

78-2

STACKS - S.B.T.



**HSL No. 78-2**  
**February 1978**

# **Highway Safety Literature**

**U.S. Department of Transportation National Highway Traffic Safety Administration**

1 copy of doc 1

100-101302-1111

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**SAE:** Society of Automotive Engineers, Dept. HSL, 400 Commonwealth Drive, Warrendale, Pa. 15096. Order by title and SAE report number.

**TRB:** Transportation Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

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## **ABSTRACT CITATIONS**

# SAMPLE ENTRIES

## FORMAT OF ENTRIES IN HIGHWAY SAFETY LITERATURE

NHTSA accession number \_\_\_\_\_ HS-013 124  
Title of document \_\_\_\_\_ **MAXIMUM BRAKE PEDAL FORCES PRODUCED BY  
MALE AND FEMALE DRIVERS**

Abstract \_\_\_\_\_  
  
The object of this research was to obtain data concerning the maximum amount of brake pedal force that automobile drivers were able to sustain over a period of ten seconds. Subjects were told to apply the brakes in the test car as they would in a panic stop, and to exert as much force as possible on the pedal over the entire ten second test period. A total of 84 subjects were tested, including 42 males and 42 females. The results indicated that there is a wide distribution of values which characterizes the pedal force that the subjects were able to generate. Male subjects produced generally higher forces than did females. Over half the women tested were unable to exert more than 150 lbs. of force with either foot alone, but when both feet were applied to the pedal, force levels rose significantly.

Personal author(s) \_\_\_\_\_ by C. R. VonBuseck  
Corporate author (or author's affiliation) \_\_\_\_\_ General Motors Corp.  
Publication date; pagination \_\_\_\_\_ 1973? ; 18p  
Supplementary note \_\_\_\_\_ Excerpts from Maximum Parking Brake Forces Applied by  
Male and Female Drivers (EM-23) BY R. L. Bierley, 1965, are  
included.  
Availability \_\_\_\_\_ Availability: Corporate author

NHTSA accession number \_\_\_\_\_ HS-018 924

Title of document \_\_\_\_\_ **NATURAL FREQUENCIES OF THE BIAS TIRE**

Abstract \_\_\_\_\_  
  
The lowest natural frequencies of a bias tire under inflation pressure are deduced by assuming the bias tire as a composite structure of a bias-laminated, toroidal membrane shell and rigorously taking three displacement components into consideration. The point collocation method is used to solve a derived system of differential equations with variable coefficients. It is found that the lowest natural frequencies calculated for two kinds of bias tire agree well with the corresponding experimental results in a wide range of inflation pressures. Results of the approximate analysis show that the influences of the in-plane inertia forces on natural frequency may be considered small, but the influences of in-plane displacements are large, particularly on the natural frequency of the tire under low inflation pressure.

Personal author(s) \_\_\_\_\_ by Masami Hirano; Takashi Akasaka  
Journal citation \_\_\_\_\_ Publ: Tire Science and Technology v4 n2 p86-114 (May 1976)  
Publication date \_\_\_\_\_ 1976; 6refs  
Availability \_\_\_\_\_ Availability: See publication

HS-020 722

### MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?

Passenger car engine oil drain intervals for normal service as recommended by manufacturers from 1946 to the present were studied with the drain intervals being intercompared with engine tests used to gauge oil performance and trends in automotive emission control. Extended drain capabilities of an oil formulation were qualified in relation to the type of service and the type of gasoline used (i.e. leaded or unleaded fuel). Technology may be available to achieve longer drain intervals in today's automobiles. Additional testing is needed under a wider variety of operating conditions to ensure satisfactory engine durability and customer acceptance in the commercial market. Based on taxicab tests, higher quality levels than current API (American Petroleum Institute) Service SE classification of gasoline engine oils are needed to double today's recommended oil change intervals (e.g. American Motors, 5000 miles or five months; Chrysler, 5000 miles or six months; Ford, 5000 miles or five months; and General Motors, 7500 miles or six months). Control of engine wear is the major technical limitation on extending oil change intervals. Other technical limitations for long drain oils are control of engine deposits and resistance to thickening. Additional work is needed to develop a consumer oriented relationship between oil viscosity increase and fuel economy/stability. A better understanding is needed of the influence of longer drain intervals on oil filter life and efficiency. Further improvements in oil filter technology should be encouraged.

by W. C. Gergel; T. J. Sheahan

Lubrizol Corp.

Rept. No. SAE-760560; 1976; 14p 14refs

Presented at Fuels and Lubricants Meeting, St. Louis, 7-10

Jun 1976.

Availability: SAE

HS-020 916

### VISCOMETER FOR PREDICTING LOW- TEMPERATURE PUMPABILITY OF ENGINE OILS

An orifice viscometer is described that can be used to identify engine oils which have potential pumpability problems at temperatures above those recommended for operation. With additional testing, inclusion of orifice viscometer limits in engine oil specifications would provide consumer protection. Tests using thirteen pumpability reference oils are carried out to determine pumping behavior in several different motored engines, which is expressed in terms of Borderline Pumping Temperature (BPT). Oils failing to meet borderline pumping criteria are characterized as flow-limited (oils too viscous to be drawn up the pump inlet tube at a rate sufficient to achieve and maintain 20 psi), and air-binding (oils unable to slump to the inlet tube entrance as fast as they are drawn up the inlet tube, allowing air to enter tube and pump, causing a partial loss of suction). The orifice viscometer is designed to operate at an extremely low shear stress with slumping flow similar to that in the engine sump. Its flow times at each oil's BPT separate air-binding oils from flow-limited oils. For viscometer identification/specification of oils which will potentially air-bind in low temperature service, a critical flow time for air-

binding, probably 300 seconds, would be required. The orifice viscometer is not intended to predict BPT's of flow-limited oils, due to already existing cold cranking restrictions, which are more restrictive than flow-limited pumping performance. Further testing is necessary for detection of unusual flow properties such as those of PRO-05 and 09. An appendix summarizes the ASTM engine test procedure for borderline pumping temperature.

by D. L. Alexander; S. W. Rein

Texaco Inc., Res. and Technical Dept.

Publ: HS-020 911 (SAE-SP-419; ASTM-STD-621-S1), "The Relationship Between Engine Oil Viscosity and Engine Performance, Pt. 2," Warrendale, Pa., 1977 p37-43

Rept. No. SAE-770632; 1977; 11refs

Availability: In HS-020 911

HS-020 978

### FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES

Information on product/service cost, alternatives for restructuring and updating fees for registration, licensing and related services, and recommendations for changes based on the analysis were developed for the California Dept. of Motor Vehicles (DMV). The fees collected are deposited in the Motor Vehicle Account and are used to support not only DMV operations but also those of the California Hwy. Patrol. Additional monies from the Account are earmarked for the Air Resources Board, the Dept. of Justice, and the Business and Transportation Agency. Any surplus funds are deposited in the State Highway Account for the support of CALTRANS (California Department of Transportation). In the past the surplus of Motor Vehicle funds used for CALTRANS roughly equaled the amount of weight fees collected, but the available surplus has decreased in recent years. Department of Finance projections indicate that both the DMV and other agencies dependent on the Account monies will experience funding deficits in FY 1978/79. To assist in the resolution of this funding problem, the following information was developed: identification of the services and products provided by the DMV and their costs, identification of those services and products for which costs are higher than the fees assessed, analysis of cost/revenue implications, identification of those services and products for which costs are higher than the fees assessed, analysis of cost/revenue implications, identification of those services and products which are provided at no cost to the beneficiary, alternatives to the present method of producing revenues and providing services, and recommendations for change. The following three basic alternatives were considered for increasing the net revenues to the Motor Vehicle Account: subsidize programs with existing revenues, reduce costs, or increase fees. This study focused on what the Department could do to provide services to the public more efficiently, rather than on how to obtain more public revenues, through fee increases, to support its operations. Exceptions to this general policy were fee increases recommended to cover the cost of services that benefit public agencies not totally dependent on the Motor Vehicle Account revenues or surplus, and fee increases recommended for services provided to persons who, by virtue of their own acts, require those services

HS-021 466

(e.g. replacement of documents lost through carelessness). Charts display the specific recommendations together with their costs and revenues. If all of the recommendations were followed, the Motor Vehicle Account would receive an estimated additional \$34,171,000, about \$5,690,000 of which would result from cost reductions and about \$28,481,000 from fee increases. The Dept. of Motor Vehicles cannot effect most of the recommended changes without legislative direction.

California Dept. of Motor Vehicles, Office of Prog. Devel. and Evaluation, Sacramento, Calif.

1977; 194p

Rept. to the Legislature of the State of California, Joint Legislative Budget Com.

Availability: Corporate author

HS-021 466

#### **VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE**

The predictions of a turbulent flame propagation model based on the original equations by Blizzard and Keck have been compared with experimental data. The model assumes that turbulent eddies are engulfed at a given entrainment speed and burn in a characteristic time equal to the eddy radius, divided by the laminar flame speed. A parametric study was made of the effects on the model of varying time, entrainment speed, and the energy release parameter which is related to the relative compression of the unburned gas ahead of the flame. Solutions were made for both thin flame and thick flame. Verification was made by measuring burn rates and ignition delays in a cooperative fuel research (CFR) engine as a function of equivalence ratio, exhaust gas recirculation (EGR), spark timing, compression ratio, and revolutions per minute (rpm). Comparison showed that, although the model could be adjusted to give correct trends in burning intervals for variations in equivalence ratio, EGR, compression ratio, spark timing, and level of turbulence, the amount of that variation was less than that observed in the experiment. Contrary to experimental data, predicted burning intervals increased with rpm. Predicted ignition delays were much less than experimental delays. Correct trendwise dependence on spark timing could be obtained for either ignition delay or burning interval, but not for both. The incorporation of a spherical flame geometry into the model did not significantly change the results obtained with the cylindrical flame. The model cannot adequately describe the experimental results, primarily because of the restrictive assumptions of constant characteristic time and entrainment speed; the model should be changed to allow for variation of these parameters with time.

by F. D. McCuston, Jr.; G. A. Lavoie; C. W. Kauffman  
Ford Motor Co., Fuels and Lubricants Dept.; University of  
Cincinnati, Dept. of Aerospace Engineering  
Rept. No. SAE-770046; 1977; 24p 28refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HSL 78-02

HS-021 467

#### **TRANSIENT RESPONSE OF A CARBURETOR ENGINE**

Investigation of the dynamic characteristics of a carburetor engine is accomplished with the use of a quick response fuel flow meter and with a new gas sampling system which measures cycle to cycle change in the air fuel ratio of the cylinder charge under transient conditions without any delay or distortion. The flow meter measures instantaneous fuel flow rate at the main nozzle of the carburetor. The experiments were performed with sudden opening and closing of the throttle at constant speed, with measurement of the response of the maximum cylinder pressure at varying initial air fuel ratios, inlet pipe lengths, inlet pipe temperatures, and engine speeds. Results show that when the throttle is opened or closed rapidly, there is no delay in air flow into the cylinder even with a long inlet pipe, nor is there delay in fuel flow at the main nozzle of the carburetor. As for fuel flow into the cylinder, the spray flow component has no delay but the wall flow component has a delay of the first order; its time constant is equal to the ratio of inlet pipe length and the mean velocity of the fuel film. There is also delay in air fuel ratio of the charge into the cylinder. Maximum cylinder pressure response differs according to the initial air fuel ratio; the shape of the response is determined by the relation between maximum cylinder pressure and air fuel ratio. At a certain initial air fuel ratio the response of the maximum cylinder pressure has no delay. An approximate theory on the fuel film flow is mathematically established to explain these results. The response of maximum cylinder pressure can be predicted if the values of inlet pipe length, mean velocity of fuel film, and initial air fuel ratio are given, as well as the ratio of liquid film flow and spray flow.

by Munenobu Tanaka; Enoch J. Durbin  
Tokyo Univ. of Agriculture and Technology, Japan; Princeton Univ.

Rept. No. SAE-770046; 1977; 16p 9refs

Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.

Availability: SAE

HS-021 468

#### **EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION**

A standard cast iron manifold and a thermal reactor were tested to study the interrelationships between engine, manifold/reactor, and turbocharger and to evaluate the possible effects of the reactor's presence on fuel efficiency. Turbocharging could overcome the loss in brake mean effective pressure caused by lean operation. The test engine was a lean burning Texaco Controlled Combustion System (TCCS) L141. The two exhaust manifold configurations studied were a conventional cast iron manifold whose volume equaled half the engine displacement and a thermal reactor whose volume was twice the engine displacement. Parameters of the study were compressor pressure ratio, turbine inlet pressure and temperature, pressure change from inlet to exhaust valves, specific fuel consumption, and comparative emissions of carbon monoxide. A thermal reactor is shown to provide increased energy to the turbine if the air/fuel mixture is rich enough, and heat and pressure losses are not excessive. Of the parameters investigated, pressure differential between the intake and ex-

haust valves was found both theoretically and experimentally to have the greatest effect on brake specific fuel consumption (bsfc). Although a thermal reactor increased boost, bsfc was increased an average of 4.6%. When a turbine follows a cast iron manifold in the exhaust gas flow path, a significant percentage of the oxidation of carbon monoxide takes place in the turbine. Reaction rates are significantly increased due to the higher partial pressures of reactants. In a lean burning engine the combination of cast iron manifold and turbine appears to be almost as effective as the thermal reactor and turbine in reducing tailpipe emissions. The marginal emissions improvements to be realized by employing a thermal reactor on a turbocharged TCCS engine as it approaches its rich operating limits are more than offset by the overall loss in energy efficiency due to the increased pumping work necessitated by the reactor's presence in the exhaust stream.

by Paul J. Kern; Oleh B. Koropey  
U.S. Military Acad., Dept. of Engineering  
Rept. No. SAE-770047; 1977; 16p 10refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 469

#### TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM

A nonlinear, two-dimensional computer model in the longitudinal and vertical directions simulates tracked vehicle dynamics when subjected to terrain inputs using the simulation language MIMIC. It establishes and numerically solves the rigid body differential equations which define the vehicle motion. Two degrees of freedom (pitch and bounce) are associated with the vehicle hull with an additional degree of freedom associated with each roadwheel station on one side of the vehicle. Terrains available for use with the model include mathematically generated and physical cross country terrains as well as manmade individual obstacles and bump courses. Program output is in the form of time histories printed out and plotted at predetermined time increments. Recent improvements in the model have been made by modifying the simulation of the dynamic compensating idler linkage. Experimental field data with which to test the model were provided by an instrumented Chrysler XMI tank test run over a manmade bump course at Chelsea Proving Grounds; good comparisons were made for both 15 and 30 mph runs. Very slight variations of input parameters, whether in the computer model or in the field, can result in much larger differences in important output parameters such as vertical acceleration. The model should be modified to include longitudinal forces and the necessary degrees of freedom to account for vehicle roll motion.

by Paul Wheeler  
Chrysler Corp.  
Rept. No. SAE-770048; 1977; 8p 6refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 470

#### ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE

#### ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT

The hypothesis is tested that the increases of alcohol-related crash involvements of 18 to 20 year old drivers in the months immediately following the reduction of the legal drinking age from 21 to 18 persisted through the first four years following that legislation, and that the response was consistent throughout the State of Michigan. In addition, the hypothesis is tested that the availability of beverage alcohol, measured both by quantity and by dollar values of sales, increased concurrently with the reduction of the legal drinking age in Jan 1972 throughout the state. The model derived for the study considers other influences on the change in beverage alcohol availability such as changes in area demographics; changes in alcohol beverage legislation, policy, and relevant court decisions; and changes in the number, classification, and hours of operation of alcohol distributing units. A multiple time-series, quasi-experimental design compared the affected population with the control population. Urban and rural jurisdictions were separately analyzed. Comparative analysis between age groups of crash-involved drivers and of single age groups between time periods was replaced by the following three-factor surrogate of sex of driver, time of crash, and number of moving vehicles: male, between 9 P.M. and 6 A.M., single vehicle. The findings are that during the four-year period, the elevated frequency of alcohol-related crashes involving male drivers aged 18 to 20 persisted. At least 4600 such crashes resulting in at least 89 fatalities are attributable to the 1972 lowering of the legal drinking age and to the increases in availability and consumption of alcoholic beverages. No significant increases in such crashes occurred among the driver age groups of 21 to 24 years or of 25 to 45 years. As for alcohol-related crash involvement among drivers aged 16 and 17, a statistically significant increase was identified in Oakland County. The fact that draught beer sales increased significantly at the time of the reduction in the legal drinking age while packaged beer sales did not, suggests that the 18 to 20 year olds were new drinkers and were drinking on premises. This would tend to contradict the assumption that the legislation was merely legitimization of presumed existing drinking habits; indeed, beverage alcohol consumption is shown to be highly variable over time, although predictable. The relatively simultaneous alterations of the influences of alcohol availability and the lowered legal drinking age have interacted to create a traffic casualty problem that might have been reduced if one or the other were held constant. The legal drinking age should be raised. More study is needed of the specific age at which alcohol-related crashes are most frequent, of female crash-involved drivers, of the availability of beverage alcohol and its relationship to various social and health problems, and of the drinking habits of young people.

by Richard L. Douglass; Jay Alan Freedman  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor,  
Mich. 48109  
Contract MDPH-384117  
Rept. No. UM-HSRI-77-37-1; 1977; 128p refs  
Rept. for Oct 1976-Aug 1977.  
Availability: Michigan Dept. of Public Health, Office of  
Substance Abuse Services, Lansing, Mich.

HS-021 471

HS-021 471

**CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS**

Issues reviewed are the potential for reducing automobile fuel consumption, the need for a more effective public information program, the need for more timely distribution of gas mileage guides, and the reliability and credibility of mileage estimates. The Federal gas mileage guide, a booklet which is updated twice a year, is not well known (only 7% of new car buyers knew of it) and was not available in dealer showrooms until several months after the new car buying season had started. The Federal Energy Administration's (FEA) promotion of gas mileage information in the model year 1976 was weak in that it relied on public service television advertising and news releases, and in that it missed the beginning, peak months of new car sales. Perhaps the gas mileage guide should be replaced by mileage comparison charts distributed to new car dealers at the time new cars become available. Federal estimates appear to be higher than what the consumer experiences. The consumer does not seem to understand how to use the estimates to advantage. The Administrator of the Environmental Protection Agency (EPA) should work toward advancing the cutoff dates of mileage testing so that the guides may be available at the beginning of the new car season. The Administrator of the FEA should evaluate the effectiveness of the gas mileage advertising program for 1977 model cars, experiment with paid advertising for the 1978 model year, use other methods than the guide for displaying mileage information in showrooms, and clearly inform the public how to use the mileage estimates. The EPA Administrator responds that an earlier cutoff date of testing is not possible for the 1978 model year but may be so for future model years. The FEA Administrator responds that use of paid advertising may result in loss of free advertising. Letters from the major automobile manufacturers concerning Federal mileage estimates are appended.

Comptroller General of the United States, Washington, D.C.  
20548  
Rept. No. CED-77-107; 1977; 93p  
Availability: Corporate author

HS-021 472

**FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT**

Modifications made to the Headlamp Visibility Distance Performance Simulation incorporating a straight road, two vehicles, a target, and an observer, have made the program more versatile and flexible. The shape of the beam patterns near their hot spots is better represented. Effects of glare from the headlamps of a following vehicle as reflected in the mirrors of the main vehicle are taken into consideration, as are the effects of horizontal and vertical road curvature. An estimate can now be made of the discomfort glare as opposed to the disability glare produced throughout the meeting. Sample runs of the program are provided as illustrations, the program itself is listed, and a detailed user's manual is included. The program, written in Fortran VI and operational on the Hwy.

HS-021 473

Safety Res. Inst. DEC 11/45 digital computer, is available for use by any interested party.

by Judith M. Becker; Rudolf G. Mortimer  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor,  
Mich. 48105  
Contract UM7204-C128  
Rept. No. UM-HSRI-HF-74-26; PB-257 909; 1974; 74p 8refs  
Rept. for 1 Jul 1973-30 Jun 1974.  
Availability: Motor Vehicle Manufacturers Assoc., 320 New Center Bldg., Detroit, Mich. 48202

HS-021 473

**YOUNG PEDESTRIAN BEHAVIOR**

The behavior of young people (ages 5 to 14 years) as pedestrians in traffic was studied by field surveys, followed by interviews with the individuals observed to determine their understanding of their habits as pedestrians while going to and from school. Pictorial questionnaires were used. The accident problem is defined by a study of national and urban accident descriptors, and of data on school walking trip accidents. Recurrent accident descriptors are children running, vision driver or pedestrian blocked, and not crossing at the intersection or crosswalk. Data were collected from 933 students in Montgomery and Howard counties, Md., Fairfax and Prince William counties, Va., and New York City; students were interviewed from kindergarten and from the sixth and eighth grades. The sample represents urban, suburban, and rural schools. Male students are more likely to travel to school alone and to take more risks than female students. Understanding and capability increase with age. Rural students are more likely to disregard traffic lights and crosswalks. Although students tend to take more risks as they get older, accident data suggest that their risktaking is offset by improved ability to make accurate judgments. Trip routes may be modified by parental pressure for the younger students and by peer pressure for the older students.

by Martin L. Reiss  
Publ: Transportation Engineering v47 n10 p40-4 (Oct 1977)  
1977; 16refs  
Based on a paper presented at Conference on Pedestrian Safety, Haifa, Israel, Dec 1976; also based on work performed for contract FHWA-RD-75-105.  
Availability: See publication

HS-021 474

**TRAVEL BEHAVIOR UNDER INCREASES IN GASOLINE PRICES**

An energy use travel survey was conducted to determine how shortages and higher prices of gasoline have influenced and may influence the travel habits and patterns of household members. The questions dealt with the following: what adjustments occurred in the household travel behavior since the rapid increases in gasoline prices that began in late 1973; how the household intends to adjust their travel behavior in response to further increases in gasoline prices, and in response to potential restrictions; attitude toward regional policies designed to deal with existing or prospective transportation facilities and costs; and the demographic and economic characteristics of the household. Questionnaires were mailed to a random sample of 9881 individuals in southeastern Wisconsin during Nov 1973; 1461 (14.8%) usable returns were received. When gasoline prices are below 60 cents per gallon, only

small proportion of households will make any significant changes in travel patterns or habits. The critical threshold is the 70 to 90 cents per gallon price category. Neither commuting distance nor the demographic location of the household is a strong determining factor. The age of the head of household does however have an influence: as age increases, the critical price threshold decreases. As income and level of education rise, the price threshold rises. The people most hurt by soaring gasoline prices are craftsmen, operatives, and service workers; they are over 30 years of age with below-average educations and they earn less than \$15,000 per year. As for attitudes toward policy, households with high price thresholds prefer paying higher prices to having restrictions, and those with low thresholds prefer rationing to price increases. Households do lessen their gasoline consumption when they reach their individual price thresholds. Data are tabulated.

by Thomas M. Corsi; Milton E. Harvey  
Publ: Traffic Quarterly v31 n4 p605-24 (Oct 1977)  
1977; 9refs  
Availability: See publication

HS-021 475

#### TRAFFIC AS A FUNCTION OF SUPPLY AND DEMAND

Area traffic congestion should be considered as a factor when estimating induced traffic for a new or improved traffic facility. The capacity of the urban street determines the amount of traffic that uses it. An exemplary case is that of U.S. Route 1 in Arlington, Va., serving both the Pentagon and National Airport: when the large Crystal City complex was developed, the estimate of daily traffic was 77,000 vehicles, but in reality only 34,400 vehicles per day used the road, and the principal intersections operated at an acceptable level of service during peak hours. The economic rules of supply and demand are applicable to the traffic estimation situation. Tripmaking is the commodity, and the cost is time. In the case of U.S. Route 1, increased cost was in the form of traffic congestion; it reduced tripmaking. The more constraint there is on travel, the greater will be the elasticity of travel demand, and vice versa. Manhattan is an example of a densely developed transportation area. Standard traffic forecasting techniques to date do not take into consideration the damping effect of congestion, or the input of induced traffic. Flaws in transportation forecasting also exist because of the constant reorientation of the journey between work and home characteristic of the U.S. population: rapidly changing trip patterns both saturate capacities of new roadways and relieve unacceptably high levels of congestion. Travel can be minimized by concentrating new developments in areas having the largest variety of land use with the highest density. New roadways in major urban areas often tend to be self-defeating, since they generate new trips but outward and not inward, thus encouraging urban sprawl. Congestion should be thought of as a useful and effective planning tool: it is not so much a problem to be eliminated as a sign of urban life.

by Robert L. Morris  
Publ: Traffic Quarterly v31 n4 p591-603 (Oct 1977)  
1977; 3refs  
Availability: See publication

HS-021 476

#### IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS

A program was developed and tested for the identification of hazardous locations on Kentucky city streets. Identification methods used by other states include the following: number; rate; severity; severity rate; probability rate; number and severity; number and rate; rate and severity; number and probability rate; number, rate, and severity; severity and probability rate; and congestion, number, and rate. The method selected for use in Kentucky is a combination of the number of traffic accidents method and the rate quality control method. The former permits a quick testing of the relative degree of hazard at different road locations by direct comparison of their respective traffic accident experience. The latter is a corrective measure which requires higher traffic accident rates for road locations having lower traffic volumes. The cities of Kentucky were grouped by population and the data for similar road locations within each city group were placed together, then their average number of traffic accidents and average traffic volume were compared. The average number of accidents so determined was used to calculate a critical traffic accident level which, when compared to the actual accident experience of individual sites, identified the more hazardous road locations. Finally, these hazardous locations were ranked by degree of hazard so that priorities could be placed on further investigations and safety improvements. Data are gathered and tabulated. A computer program was written to give a priority listing of degrees of hazard of highway locations for cities individually or collectively. About 1400 locations annually will be identified as hazardous.

by Charles V. Zegeer; Robert C. Deen  
Publ: Traffic Quarterly v31 n4 p549-70 (Oct 1977)  
1977; 12refs  
Availability: See publication

HS-021 477

#### HABIT CHECK OF SEEING AND RESPONDING IN DRIVING

The revised version of a system for checking in traffic the seeing and responding habits of drivers is used by many commercial trucking companies. Findings from its use by motor fleet drivers show that all drivers have some need for improvement, that faulty driving habits cause most traffic accidents, and that the habit check reduces accidents in most fleets. The system is also applicable to other drivers, as few drivers can build correct seeing and responding habits by experience alone; they can reduce their chances of traffic accidents and can correct bad habits by using the system. The system conditions the driver in the following five processes: steering glances, timing (speed/distance judgment) glances, detection glances, space cushion responses, and warning signal responses. Steering should be done by brief glances far ahead at the middle of the driving lane or turning path. Timing glances include, while keeping at least one car space for each ten miles of speed, not looking directly at nearby vehicles and moving the eyes every two seconds. Detection glances include glancing a full block or a quarter of a mile ahead, watching for trouble from the sides, and checking the rearview mirror at least every eight seconds. Space cushion responses involve either moving up or dropping back in traffic to try to ride alone, accelerating quickly when passing so that the driver being overtaken can see the passing vehicle, and positioning the foot over the brake pedal prior to

maneuvering hills, curves, blind intersections, or other trouble spots. Warning signal responses include two short taps on the horn or flashing upper and lower headlight beams in doubtfully safe situations, early signaling of turns or lane changes, and pumping the brake rapidly or using hand signals in the case of a surprise slowdown. The habit check requires at least an hour of observation in heavy but steadily moving traffic. A habit checklist is provided, with instructions on how to grade the driver. Except for lane position and following distance, a single error is proof of a faulty habit.

by John J. Cummings

Publ: Traffic Quarterly v31 n4 p533-47 (Oct 1977)

1977; 4refs

Availability: See publication

HS-021 478

#### **PUBLIC PARTICIPATION IN TRANSPORTATION PLANNING**

There are sociological considerations and specific participation techniques which should be understood in order to have good participatory transportation planning. The following comments are axiomatic. The public is actually a collection of diverse interests and values. Communities can be based on geography, interests, or values. Participants may not be representative of the entire community, or of those for whom they claim to speak. Concerns of self-interest are often couched in value terms. It is easier to get people to participate in transportation planning when the expected result will be a concrete decision on a specific facility that will affect them immediately. Any planning decision is political as well as technical; results will not be optimal. It must balance the considerations of process and product. The participatory planning process is one of mutual education of and by the public and the planner. The public should be asked to participate frequently; such participation should be made an integral part of the planning. No single technique is appropriate; good faith is as important as any technique. The interdisciplinary planning team should include a social scientist. Claims of expertise on the part of team members need to be balanced with an understanding of other fields of knowledge. Effort should be made to learn the feelings of citizens other than those who are highly active. Among the possible techniques are use of the advisory committee, field work, key informants, public meetings, simulation, small meetings, surveys, and television. Participatory planning certainly does not mean bad planning, nor is it a naive concession to the idea of democracy. Participatory planning has already proven itself successful.

by Barry Wellman

Publ: Traffic Quarterly v31 n4 p639-56 (Oct 1977)

1977; 9refs

Availability: See publication

HS-021 479

#### **FRONT-WHEEL DRIVE**

A review is given of the history, current status, and manufacturing trends of front wheel drive in motor vehicles. The very first motor vehicle had front wheel drive. No mass producer would touch it, however, until Austin's 1959 introduction of the Mini. Rear wheel drive would seem preferable given the normal weight distribution in a vehicle. Front wheel drive vehicles, however, usually carry 57%-72% of their static

weight on the front wheels to optimize traction. There is a trend, especially in small cars, toward driving the wheels at the end which holds the engine. This year 95% of all cars made in France will have front wheel drive; this trend is strong among other European and among Japanese manufacturers. As for the U.S., various manufacturers are planning to introduce front wheel drive in compacts and subcompacts. There is an extra cost in manufacturing front wheel drive compared with rear wheel drive, but that could be outweighed by corresponding manufacturing changes such as drive shaft elimination. Advantages of front wheel drive include more interior space, free positioning of the engine, greater ride comfort, compatibility with popular independent suspension systems, reduction in vibration, easier elimination of gear noise, better handling, superior high-speed stability, and less tendency to oversteer. A wider turning circle is not a unique characteristic of front wheel drive vehicles, as is commonly supposed. Front wheel drive vehicles are subject to a higher risk of premature rear wheel locking during hard braking.

by Jan Norbye

Publ: Road and Track v29 n3 p45-50 (Nov 1977)

1977

Availability: See publication

HS-021 480

#### **EVALUATION OF A HUB ASSEMBLY**

An automatic simulator and test schedule for wheel bearing assemblies were devised to represent true driving conditions. To develop a test schedule for wheel hubs the emphasis should be on the lateral acceleration since it is the dominant factor in wheel hub bearing design. The test schedule used by Leyland Cars is recommended, noting that fatigue wear curves and block diagrams will differ for each vehicle. The area under the blocks should compare with the area under the curves, which represent fatigue wear. The relationship between equivalent load and fatigue life allows the loads to be factored up with a consequent cubic reduction in test time. Four hubs are loaded as two pairs back to back, mounted symmetrically to a dummy wheel. The rig allows the hubs to move in the direction of the three load components so that they can freely deflect relative to one another. Loading is done by pneumatic cylinders through strain-gauged linkages. The shafts of the test rig had to be hardened to reduce the incidence of failure; standard hub parts are used, however.

by S. Y. Poon; S. G. Williams

Publ: Automotive Engineer v2 n4 p16-9 (Aug/Sep 1977)

1977; 10refs

Availability: See publication

HS-021 481

#### **THE SAFEST WAY TO CRASH...DON'T. AN EXAMINATION OF EMERGENCY BRAKING TECHNIQUES**

Advice is given on braking a motorcycle in emergency situations. All such action involves either maneuvering safely out of harm's way or stopping prior to impact. Laying the motorcycle down is not a good choice; in terms of safety analysis, it is equivalent to turning the bike into a sled with metal runners, with all control lost. The tires and brakes should be used to help stop the bike. Examination of a table of stopping distances at various speeds shows that the stopping becomes

faster as the speed diminishes. Even if speed is reduced to something under 15 mph, a crash can be survivable: except for the head, the vital parts of the body can withstand impacts of up to 15 mph. An understanding of reaction time is just as important as understanding stopping distances. Anticipation is the key word in motorcycle driving. The motorcycle driver should practice full-lock stops. The proper emergency front-wheel braking technique involves playing the brake by squeezing the forward brake lever with maximum pressure, releasing that pressure for a brief second, then squeezing again. Positional attitudes the bike may take are roll, pitch, and yaw. In the emergency braking situation, the rear wheels should be locked up to keep the bike's yawing under control. Once the driver is committed to a locked-wheel braking stop, he or she must stay on the brakes until the bike is stopped.

by Robert Nichols  
Publ: Driver v11 n4 p20-7 (Sep 1977)  
1977  
Availability: See publication

HS-021 482

#### TAXICAB OPERATING CHARACTERISTICS. FINAL REPORT

Mail surveys of taxicab fleet operators in 1974 and in 1976 produced data which are analyzed in terms of types of operations, vehicles and services provided, industry structure, passenger operations, utilization of employees and vehicles, cost and revenue relationships, and fare structure. Although response rate was only 10.8% in 1974 and 4.7% in 1976, the samples provide broad geographical and fleet size coverage. Commission type operations increased from 66.3% to 71.2%; lease type operations increased from 7.7% to 12%. Other types of operations include the owner/driver type and combinations of those three types. Most fleet vehicles (85%) were taxicabs; limousines, buses and school buses, and (increasingly) vehicles designed to accommodate the handicapped are also included in fleets. Taxicabs usually had two-way radios. In addition to on-demand taxicab service, operators also provided on-demand package delivery services (over 71%), emergency services (nearly 50%), and special services for the handicapped (25%), as well as pre-arranged service for school children (44%), company employees (43%), hospital patients (31%), government employees (11%), senior citizens or public aid persons (10%), and blood and hospital supplies (5%). Although two thirds of the taxicab operators had less than 25 taxicabs in their fleets, most activity was concentrated in fleets having 200 or more cabs. Comparison of the taxicab industry with various modes of public transportation shows that taxicabs haul over half as many passengers per year as do buses and over 600 million more passengers than do the railroads. In addition, the taxicab or paratransit industry has twice the annual revenue of the bus transit industry and at least \$1 billion more than the transit industry as a whole, and employs about three times the number of persons that the bus transit industry does and over twice that of the entire transit industry. A study of the operating characteristics of taxicab fleets shows that those having less than 100 taxicabs increased in productivity but that those having more, declined. Vehicle miles per trip declined generally. Increases in the number of employees per taxicab illustrate the contrarecessionary character of taxicab industry employment. Profits have declined from 1970 to 1975 to such an extent that revenues of 50% of the companies did not cover total costs including capital costs and the revenues of 25% did not cover even out-of-pocket costs. Use of fare meters increased from

62.4% in 1974 to 71% in 1976; the zone system is usual when meters are not used. Fare structures for meter systems shifted toward higher initial mileage charges and shorter length of the initial mile; additional mileage charges remained about the same but the length of the additional miles decreased. An example of fare increases is that of the three mile trip, for which the fare increase was 10%-11%.

Control Data Corp., 6003 Executive Blvd., Rockville, Md.  
20852; Wells Res. Co.  
Rept. No. DOT-TPI-10-77-22; 1977; 108p  
Availability: NTIS

HS-021 483

#### GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY

Data summary tables and data traces are presented for the following tests of the Hybrid III anthropomorphic test dummy (ATD): repeatability and reproducibility series, X-body (Nova) sled series for dummy durability, and full scale barrier series for dummy durability. The repeatability and reproducibility series included six replicated tests of each of three dummies. The parameters for which repeatability and reproducibility were determined were head injury criteria (HIC) I, chest severity index (SI), chest maximum deflection, and pelvic SI. A rigid seating structure was used which had a seat pan angled at 10° and covered with 0.5 inch 50-durometer natural rubber, and a seat back angled at 21°. The dummies were set up as close as possible to the ATD-502 master template. A three-point lap and shoulder belt restraint system of nylon webbing was used. The sled acceleration pulse was a half sine with a peak of 33.8 g's and a duration of 77 ms. The coefficients of variation used to quantify repeatability and reproducibility are presented. Durability was measured on the Hyge sled by running 30 mph frontal barrier simulation tests with a reinforced, 1975 X-body (Nova) fixture. Three replicated tests were run for both unrestrained and lap-shoulder belt restrained dummies in the right front occupant position. Vinyl bench seats and polyester lap-shoulder belts of 1976 production were used. The lower instrument panel was reinforced and padded. The full scale barrier tests were made at 30 mph using modified 1977 Chevrolets as B-car and modified 1977 Chevettes as T-car. The dummies were placed in the driver and right front positions, and were unrestrained in one set of tests and restrained with production, continuous loop, lap-shoulder belts in the other. Dummies were positioned according to the procedure described in Federal Motor Vehicle Safety Standard (FMVSS) 208. The B-car seats were bench type and the T-body seats were bucket type.

General Motors Corp.  
Rept. No. USG-1502-Pt-4; 1977; 295p  
Availability: Reference copy only

HS-021 484

#### USE OF SODIUM AZIDE FOR AIR CUSHION INFLATOR

The suitability of sodium azide as the gas generant for air bags has been investigated, and the conclusion reached that the chemical is not hazardous when used with a metal oxide to prevent the formation of metallic sodium and with a filter to

remove any sodium oxide that is formed. The choice of cupric oxide (CuO) as the metal oxide seems surprising but three years of tests show it to be a good one. Sodium azide solutions form hydrazoic acid if the pH is allowed to drop below 9.5; hydrazoic acid will react with copper azide. An open container of sodium azide solution will slowly decrease in pH and form hydrazoic acid; a sealed solution will remain stable. Sodium azide will form copper azide with copper salts only to the extent of the copper salt solubility in water; insoluble copper salts do not form copper azide. Mixtures of sodium azide and copper salts do not form copper azide at pH 10.3 or higher. Copper azide must be concentrated to detonate. Dilution with sodium azide/copper salts inhibits the detonation. Vibration or heat above 140° F destroys copper azide in the propellant (TAL-1101) without causing a premature inflation. Inflators containing 1.5% copper azide in TAL-1101 behaved normally on ignition. Laboratory test reports upon which these observations were based are appended.

Talley Industries, Mesa, Ariz.

Rept. No. CFP-0058; 1975?; 115p

Includes Talley Industries Technical Lab. Reports 323, 327, 331, and addendum to 331.

Availability: Reference copy only

HS-021 485

**INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT**

A recommended railroad/highway crossing design is based on innovative concepts for train-activated protection equipment. A communication link concept involves detection of a train by a magnetic sensor at the end of the crossing approach and communication of the signal to the crossing control circuitry via VHF transmission. A solid state microprocessor control subsystem is proposed. Red flashing strobe lights are recommended for indicating presence of a train, with horizontal amber flashing lights as a malfunction indicator. Train activated advance warnings could be radio-controlled from the crossing, with amber lights. An engineer warning signal could use three different modes of illumination to signal presence of a train, malfunction, and system dead. The total recommended system should have the following characteristics: constant warning time for almost any train movement pattern; no confusion of a malfunction with a warning signal; no electrical connections with the rails; easy installation and maintenance of sensors; failsafe operation; low power consumption; and adaptability to a variety of crossing situations. The four subsystems are sensors, communications, signals or displays, and controls. The preferred sensor is the magnetic, Hall effect device. The preferred communications link can be buried cables, carrier, or VHF. The preferred signal or display subsystem should include the following: a motorist crossing warning signal consisting of a high visibility crossbuck with horizontally alternating red strobe lights for the stop signal and vertically alternating amber lights for the malfunction signal; a motorist active advance warning signal as an option; and an engineer warning signal to indicate a failed crossing warning system ahead. The preferred control subsystem should use a microprocessor as the central controlling element, a sensor pair system, 24 volt supply, and failsafe monitoring. Recharging of remotely controlled signals may be by solar panels or by wind generators. Detailed cost estimates show that the

proposed system for a basic rail crossing would cost 46% more than present designs.

by F. H. Raab; M. C. Brooker; T. E. Ryan; J. R. Waechter  
Cincinnati Electronics Corp., 2630 Glendale Rd., Cincinnati, Ohio 45241

Contract DOT-TSC-841-1

Rept. No. FRA/ORD-77/37.I; DOT-TSC-FRA-76-19.I; 1977; 208p refs

Rept. for Mar 1974-Mar 1976. Vol. 2 is HS-021 486.

Availability: NTIS

HS-021 486

**INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT**

A recommended railroad/highway crossing design is based on innovative concepts for train-activated protection equipment. A new form of track circuit called Train Ranging and Correlation System (TRACS) is suggested which relies on the characteristics of the track as a transmission line: through the use of correlation techniques, elapsed time from origin of a signal at the crossing to receipt of its reflection from a train can be measured to precisely define train location. Successive determinations of location yield velocity and direction of travel information. Use of an open graded asphalt friction course on the roadway would reduce stopping distances under heavy rainfall conditions by half. The course is a thin layer of aggregate having a porous structure and bound with either asphalt (for sharper aggregate) or epoxy (for finer aggregate). It serves to reduce glare, splash, and slickness and has different acoustical properties from the typical roadway surface. Optically programmed traffic signals are more visible than typical signals and have a zoning capability such that a driver near the intersection can see an amber signal and, simultaneously, a driver further back can see a red signal. The total recommended system should have the following characteristics: operational applicability in three to five years, grade crossing specificity; cost acceptability, constant warning time, ability to be integrated into larger traffic control systems, and ability to operate continually upon failure of normal power source. Any system needs to be evaluated according to the concepts of train detection, communications systems, protection and warning at the crossing, advanced warning concepts, impact attenuation devices, self-contained power sources, and modification of driver behavior. Cost estimates could not be made for the recommended crossing design, but a discussion is presented of the factors to be considered in making such estimates.

by D. D. Peterson; D. S. Boyer  
Tracor-Jitco, Inc., 1776 E. Jefferson St., Rockville, Md. 20852

Contract DOT-TSC-842-2  
Rept. No. FRA/ORD-77/37.II; DOT-TSC-FRA-76-19.II; 1977; 97p 6refs

Rept. for Jun 1974-Mar 1976. Vol. 1 is HS-021 485.

Availability: NTIS

HS-021 487

**STUDY OF AUTOMOBILE MARKET DYNAMICS.  
VOL. 1. DESCRIPTION. FINAL REPORT**

A national sample of new car buyers was asked in early 1976 to predict their new car buying behavior up to 1981 given five different hypothetical cases: no change from the present ("as is"); slight rises in gasoline and new car prices ("base case"); price of gasoline rises to \$1 per gallon by 1980 ("gas tax"); taxes of from \$100 to \$500 on energy-wasteful cars by 1980 ("excise tax"); and limitations on sales of energy-wasteful cars as a means of achieving fleet averaged fuel economy ("regulation"). Estimates of new car sales for each scenario were then made by the use of switching matrices. The percentages of large car buyers who would buy the same car as originally planned are, for the base case, 93%; for the excise tax, 80%; for the regulation, 76%; and for the gas tax, 65%. The percentages of small car buyers who would buy the same car as originally planned are, for the base case, 94%; for the excise tax, 96%; for the regulation, 96%, and for the gas tax, 92%. Percentages for all new car buyers given the four cases are 93%, 86%, 83%, and 73% respectively. Given that the intent of the scenarios was to attract the buyer to a smaller car, the most effective scenario was that of the gas tax. A trend to smaller cars would be in effect a trend toward more foreign car sales since the domestic manufacturers do not yet offer many small models. Proposed government policies emphasize economic stimuli on consumers, but many noneconomic variables also affect their choices of new cars. New car buyers are more affluent and less affected by economic considerations than most people. Risk avoidance and expressions of personality, social status, and values are also potent influences in choice of car. Trade-in policies of dealers encourage loyalty to brand and size. Changes in new car buying will affect the total fleet slowly since new cars account for only 12% of the total fleet in a given year. Reducing the market share of large new cars by regulation will tend to increase cost of large used cars and thus to penalize large, low income families whose needs are best served by a single, large used car. The relationship between reduction of car size and savings of fuel is complicated by such factors as multiple car ownership and multiple trip purposes. Because a sizable proportion of new cars is sold to fleet buyers, an estimation of the effectiveness of government incentives should consider the quick response of fleet buyers as compared to that of consumers. The gas tax would be inflationary and somewhat regressive, although it is the most influential of the incentives. The excise tax would be a disincentive stronger for the smaller than the larger car and would help increase the price of large used cars. The regulation case, which has become law, has tended to result in technological changes for weight reduction rather than in shifting of the ratio of large to small cars. More studies of automobile marketing dynamics should be made in the areas of fleet buyers, the used car market, car buyer behavior over time, multiple car owners, and the market in vans, pick-ups, and recreational vehicles.

by A. S. Morton; S. T. Strong; E. I. Metcalf; G. A. Marple; A. Freedman  
Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140  
Contract DOT-TSC-1060-1  
Rept. No. DOT-TSC-OST-77-1.I; AL-78542-06-1; 1977; 114p  
Rept. for Jul 1975-Nov 1976. Survey field work performed by Bee Angell and Associates, Inc., under subcontract. Vol. 2 is HS-021 488.  
Availability: NTIS

HS-021 488

**STUDY OF AUTOMOBILE MARKET DYNAMICS.  
VOL. 2. ANALYSIS. FINAL REPORT**

Statistical analyses are described for a data base of information based on a survey of new car buying behavior given various economic incentives and government regulation. A sample of new car buyers had been asked in early 1976 to predict their new car buying behavior up to 1981 given five different hypothetical cases: no change from the present ("as is"); slight rises in gasoline and new car prices ("base case"); rise in price of gasoline to \$1 per gallon by 1980 ("gas tax"); taxes of from \$100 to \$500 on energy-wasteful cars by 1980 ("excise tax"); and limitations on sales of energy-wasteful cars as a means of achieving fleet averaged fuel economy ("regulation"). There were 705 interviews of suburban residents of the metropolitan areas of Atlanta, Ga., Buffalo, N.Y., Chicago, Ill., Denver, Colo., Indianapolis, Ind., Los Angeles, Calif., and New Orleans, La. Cars were labeled as small, medium, or large not only on the basis of body and engine size but also on the basis of performance, styling, and luxury features reflected in the price; a listing of the categorization is appended. In several cases, cell sizes were extremely small. Postponement of purchase is understated in earlier years and overstated in later years. The questionnaire was sufficiently complicated that accurate completion was difficult. Impact analysis is hampered by lack of data gathered over time and by inability to describe switchers. Relative impact, however, can be derived from the data. Data are tabulated for characteristics of respondent households, odometer readings of each car owned by the household, data on the new car to be purchased and on the car currently owned, and the switching patterns in the scenarios. A new car sales forecasting model was made based on matrix multiplication theory. The two major components of the data base are an initial forecast of new car sales for the "as is" condition and the switching matrices. The unit forecasts (which form the basis of vol. 1) are graphed.

by A. S. Morton; S. T. Strong; E. I. Metcalf; G. A. Marple; A. Freedman

Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140  
Contract DOT-TSC-1060-1  
Rept. No. DOT-TSC-OST-77-1.II; AL-78542-06-1; 1977; 72p  
Rept. for Jul 1975-Nov 1976. Survey field work performed by Bee Angell and Associates, Inc., under subcontract. Vol. 1 is HS-021 487.

Availability: NTIS

HS-021 489

**DYNAMIC MODELS OF THE U.S. AUTOMOBILE FLEET. FINAL REPORT**

Two alternative specifications of a dynamic model of the U.S. automobile fleet were tested in a series of simulations. The first explicitly represents new car sales and scrappage, with overall fleet size determined as a residual. The second explicitly represents total fleet size and scrappage, with new car sales determined as a residual. These specifications contrast with the current model used by the Transportation Systems Center, in which new car sales and fleet size are explicitly represented and scrappage is the residual. Results with the new car sales specification suggest that important instabilities arise from positive feedback through fleet size, average miles driven per car, and scrappage. The fleet size specification exhibited more stable behavior and more accurate forecasts of scrappage and new car sales. The auto fleet and its dynamic

mechanisms are not very sensitive to disturbances in the long run. The increased gas prices in 1974 are a good example: the resultant small fleet size relative to growing population quickly caused recovery as used car prices increased, thus stimulating new car sales. Ultimately, external variables such as disposable income or demographic characteristics determine the trendline for the system. It is the trendline that represents an equilibrium growth pattern toward which the system recovers following disturbances. Real socioeconomic systems are inherently stable: if they could not recover from disturbances they would not survive. Stability is achieved by negative feedback and by saturation. The new car sales specification fails to recognize saturation points for either new car sales or for total fleet size; the alternative specification does, however. Future research should pay further attention to incorporating such saturation points in a dynamic fleet model. As for computer methodology, the use of DYNAMO as a language offers neither significant advantages nor disadvantages except when programming time is at a premium.

by F. T. Rabe

Environmental Impact Center, Inc., 55 Chapel St., Newton, Mass. 02158  
 Contract TS-9961  
 Rept. No. DOT-TSC-OST-77-26; 1977; 42p 7refs  
 Rept. for Mar-Jun 1975.  
 Availability: NTIS

#### STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS

Available research results on the relationship of studded tires to highway safety were gathered via an intensive review of the literature, and models of accident causal chains were developed. Models take into consideration preconditions, active factors, and main effects. Pavement wear and marking by studded tires have been suspected of causing such hazards as tire hydroplaning and wet skid, increased pavement maintenance hazard, splash and spray, vehicle lateral placement shifting, vehicle transverse forces and steering effects, driver fatigue resulting from noise and vibration, ejected studs thrown from high-speed vehicles, and vehicle component degradation. In the case of hydroplaning, studded tire wear was found to be both beneficial and detrimental to safety: the wear may coarsen such surfaces as topeka or asphaltic concrete or may have a smoothing effect. If projections of road maintenance activity resulting from studded tire wear hold true, construction sites may be a significant source of accidents. Studded tire pavement ruts can increase the number of splash-related accidents. The relationship of wheelpath wear to accident rate is not adequately understood; more research is in order. Stud-induced ruts may be related to adverse side forces and steering effects. Studies of fatigue from vibration and noise are too subjective to form the basis of a judgment, although the noise problem is considered a minor accident factor. The danger of ejected studs is about equal to that of an ejected stone of similar weight; the stud itself has little kinetic energy. Studded tires may contribute to vehicle component degradation as an accident factor in that loading cycles are affected; however, the effect is minor. Wear of suspension may be caused by exposed aggregate and longitudinal ruts due to studded tires. More research is needed in accident causation mechanisms, in-service mechanism identification, and accident data analysis. Appended are a synthesis of research results, an

in-service prediction of hydroplaning and wet skid, a proposed research plan, and an extensive bibliography with citations arranged alphabetically within each of 15 different subject categories.

by J. S. Creswell; D. F. Dunlap; J. A. Green  
 University of Michigan, Hwy. Safety Res. Inst.  
 Rept. No. NCHRP-176; 1977; 51p 260refs

Sponsored by the American Assoc. of State Hwy. and Transportation Officials and the Federal Hwy. Administration.  
 Availability: National Res. Council, Transportation Res. Board, Washington, D.C. \$4.00

#### DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT

The instrumental measurement of chromaticity is proposed as a replacement of current standards for vehicular and pedestrian traffic control signal heads. Current standards are based on use of certified limit filters which are no longer available. Most vehicular and pedestrian traffic signal lenses are made of molded polycarbonate; other materials include glass and acrylic. Tests were made of 12 inch wide angle lens for vehicular signals and of 12 inch square lenses for pedestrian signals. A detailed history of, and technical basis for, vehicular pedestrian signal color specifications and measurements are presented. The four types of colorimetric test methods are visual colorimetry, spectrophotometry, spectroradiometry, and tristimulus colorimetry; they are described and evaluated. Visual colorimetry was shown to be unsatisfactory. The spectroradiometric procedure is more accurate than the tristimulus method, although both are satisfactory. Spectrophotometry may not result in a true measure of the signal chromaticity. Data are presented of measurements taken with the Pritchard and the TRI-RAD colorimeters. Standards of performance for vehicular and pedestrian traffic signal control heads should be based on tests of complete assemblies, preferably in their end use form. Chromaticity should lie within the specified limits at all angles for which a luminous intensity requirement exists and for all light source color temperatures from 2350 K to 2856 K. The chromaticity of the pedestrian signals should lie within the specified limits at all angles from 20° left to 20° right on the horizontal axis and from horizontal to 10° down on the vertical axis for all light source color temperatures from 2350 K to 2856 K. The obsolete transmittance requirements should be eliminated from the standards and replaced with luminous intensity pattern requirements for each color of vehicular signals and with luminous requirements for pedestrian signals. Colorimetric tests should be instrumental, i.e. use physical colorimeters that are capable of collecting either relative spectral data or relative tristimulus data from which International Commission on Illumination (CIE) chromaticity coordinates can be calculated or which are automatically calculated by the instrument. There is no further requirement for color limit filters as they are presently defined; color filters should rather be of nearly the same relative spectral transmittance as the lenses being measured. Recommended luminous intensity values for vehicular signals and the luminance requirements for pedestrian signals should be verified by a comprehensive test program of all types and sizes of lenses. Recommendations for revision of the Inst. of Traffic Engineers (ITE) standards are given in the form of revised text. Procedures are detailed for measuring luminous intensity, luminance, and chromaticity. Availability and approximate costs of nonstan-

february 28, 1978

HS-021 494

dard testing equipment are listed. A glossary of terms is appended.

by David F. King  
Ann Arbor Testing Labs., Inc., P.O. Box 2078, Ann Arbor,  
Mich. 48106  
Contract DOT-FH-11-9158  
Rept. No. FHWA-RD-77-93; 1977; 114p 16refs  
Availability: NTIS

HS-021 492

#### A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT

The 245 citations in the categories of crash severity, accidents, crashworthiness, and biomechanics are a representative rather than exhaustive listing from the Hwy. Safety Res. Inst. Information Center collection. Citations are arranged by author within each category, and contain title, availability, and pagination, as well as report number(s) and cross references when applicable. The 81 citations listed under the category of crash severity cover a number of specific crash severity measures ranging from vehicle damage classification schemes to derived measures and direct measures, either engineering or statistical. In addition, some reports discuss the relationship between field and laboratory results, and the need for crash severity measures as a basis for countermeasure evaluation. The 79 citations listed under the category of accidents concern both data analysis and accident reconstruction, specifically injury prediction techniques, stratification techniques, field techniques, impact dynamics, and computer simulation applications. Among the many suggestions for crash severity measures are those directly related to acceleration, velocity, or distance/time (either actual or barrier equivalent) and those which are indirect, such as impact configuration, vehicle size, percent of vehicle overlap, and windshield bond separation. The 53 citations listed under the category of crashworthiness refer to vehicle impact testing, both actual and simulated, and to overall vehicle and structural crashworthiness. They are primarily concerned with crash energy management and passenger compartment collapse as related to the trauma sustained by the vehicle occupants. The 32 citations listed under the category of biomechanics deal with both human tolerance and occupant simulation with emphasis on the relationship between impact tolerance and the automotive impact environment. They illustrate both the early human tolerance indexes based on severity thresholds empirically derived from acceleration time histories and the more current indexes based on biomechanical models. The bibliography also contains a listing of abbreviations and acronyms and a discussion of conflicting crash severity measures.

by Joseph C. Marsh, 4th; Kenneth L. Campbell; Upendra Shah  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor,  
Mich. 48109  
Contract MVMA-361122  
Rept. No. UM-HSRI-77-22; 1977; 88p refs  
Rept. for Phase 1, Mar-Jun 1977.  
Availability: Motor Vehicle Manufacturers Assoc., 320 New Center Bldg., Detroit, Mich. 48202

HS-021 493

#### PUBLIC ATTITUDES ON RESTRAINT SYSTEMS: AN ANNOTATED BIBLIOGRAPHY

The 52 citations are listed under the categories of U.S. studies on air bags or air bags and seat belts and both U.S. and foreign studies on seat belts only. Citations are arranged chronologically within each category, and contain title, availability, and pagination, as well as report number(s) when applicable. The literature contains repeated references to negative reactions to seatbelt use, as well as objections to the cost of air bags. Canadian and Australian studies, however, consistently show approval of mandatory safetybelt usage laws, with approval increasing after the legislation has been enacted.

by Ann C. Grimm  
University of Michigan, Hwy. Safety Res. Inst., Huron Pkwy.  
and Baxter Rd., Ann Arbor, Mich. 48109  
Rept. No. UM-HSRI-77-32; 1977; 24p refs  
Availability: Teknekron, Inc., 4701 Sagamore Rd.,  
Washington, D.C. 20016

HS-021 494

#### INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM

The Dynamic Response of Articulated Machinery (DRAM) program interactively simulates vehicle and machinery designs by determining the time response (displacements, motions, and forces) of two dimensional, discrete, constrained, dynamic systems undergoing large-displacement time response. A flow diagram of a typical user problem shows the numerical integration process required to solve nonlinear, second order differential equations of motion. DRAM reads data phrased in a problem oriented language established from entities assumed to comprise a two dimensional, discrete dynamics problem: parts, markers, rotations, translations, fields, and generators. Program structure allows for programming simplicity, variable dimensioning, no need for special data access routines, and Fortran compatibility. The program is limited to rigid body systems. The choice of tree branch coordinates has resulted in a small set of differential equations. As for graphic output, storage tube terminals show single static output frames for each specific output step, and refresh display terminals show a continuously moving mechanism schematic. Simulation of impact incorporates the impact in much the same manner as an ordinary applied force: zero during separation and having an unusually high stiffness throughout the period of contact. Frictional forces which are entirely dependent on system displacement, velocity, and time are treated routinely, but the representation of Coulomb friction is a problem. A modification to the program now allows fields between circular and flat surfaces. DRAM can solve static balancing and static configuration type equilibrium problems.

by M. A. Chace; J. C. Angell  
University of Michigan  
Rept. No. SAE-770050; 1977; 15p 22refs  
Presented at International Automotive Engineering Congress  
and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 495

### SYMPOSIUM ON CURRENT ISSUES IN TRANSPORTATION POLICY

Ten essays and an extensive literature review deal with public policy of transportation, incorporating such themes as political ideology, equity, the environment, economics, communications, the handicapped, and systems analysis. A comparison is made between Sweden and the U.S. in terms of their political ideologies as they affect transportation policy. A study of the air transportation infrastructure as a problem in policymaking deals with the loss of consensus favoring airport development in the industrialized world. The equity issues in urban transportation include fee for service, equality in service distribution, and service distribution according to need. The two environmental issues considered are the passage of the National Environmental Policy Act and the matter of transportation noise. Economic regulation in the U.S. aviation industry in the 1960's and 1970's is reviewed, noting the movement toward deregulation. Demonstration, including both experiment and example, is an important factor in policy innovation. Improvement in communications is seen to be in a trade-off relationship with transportation, since it reduces travel demand. Policy determination research is categorized according to the type of political system studied (city, state, or nation) or by the type of policy. A study of national policy towards the handicapped takes note of the developing consensus that a handicap is a social and not a health problem, and discusses the effects of sections 503 and 504 of the Rehabilitation Act of 1973 as well as the influence of the 1977 White House Conference on Handicapped Individuals. Policy analysis on Capitol Hill is done by the Congressional Budget Office, the Office of Technology Assessment, the Congressional Res. Service, and the General Accounting Office; their particular concerns are tabulated and discussed. A literature review essay deals with setting national priorities, and reviews and notes are given of recent literature relevant to transportation policy. The pros and cons of systems analysis in policy studies is considered, and a bibliography is presented of specific problem areas in policy studies.

Publ: Policy Studies Journal v6 n1 p5-131 (Autumn 1977)  
1977; refs

Availability: Policy Studies Journal, 361 Lincoln Hall, Urbana,  
Ill. 61801

HS-021 496

### HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976

Safety program information is summarized from the Materials Transportation Bureau, the Federal Aviation Administration, the Federal Hwy. Administration, the Federal Railroad Administration, and the Coast Guard. Activities relevant to Section 104, Designation of Hazardous Materials, included designation of four new hazard classifications, a proposal for a blasting agent classification, and request for comments regarding regulation of certain classes of materials posing environmental and health hazards. As for Section 105, Regulations Governing Transportation of Hazardous Materials, there was a consolidation of regulations into a single set in Title 49, Code of Federal Regulations, except for those concerning bulk chemicals aboard ships. In addition, 61 amendments were

made to such regulations in Title 49, and 21 Notices of Proposed Rulemaking were published in the Federal Register. Under Section 106, Handling of Hazardous Materials, new registrations were issued to 22 drum reconditioners and 12 manufacturers of Specification 39 cylinders. Activities relevant to Section 107, Exemptions, included granting of 571 exemptions or renewals and denial of another 71. Of 55 applications for emergency exemptions, 45 were granted. Certain exemptions and applications were converted by an expedited rulemaking process into amendments. Activities under Section 108, Transportation of Radioactive Materials on Passenger-Carrying Aircraft, included study of surveys concerning the extent of radiation exposure to cargo handlers in air transportation; exposure is within established exposure guidelines for the public. Activities relevant to Section 109, Powers and Duties of the Secretary, included educational activities reaching nearly 96,000 persons, more than 28,000 inspections of facilities, and about 55,400 inspections of transport vehicles. In addition, research and development studies concerned fire testing of packaging, development of emergency service training courses, testing of insulation systems for railroad tank cars, stress corrosion cracking in cargo tanks, and material hazard classification. Activities under Section 110, Penalties, included initiation of over 2200 civil penalty actions or criminal cases and completion of rulemaking to establish enforcement procedures of the Materials Transportation Bureau. Nearly one million pieces of hazardous materials training information were distributed by the Dept. of Transportation to meet the public demand. Reporting of hazardous materials incidents in transportation increased by 10% in 1976, fatalities decreased 33%, and injuries increased 25%. Appended are the following: the Transportation Safety Act of 1974, a summary of hazardous materials legislation, 1976 hazardous materials rulemaking, and a description of research and development projects and reports. Also appended are a list of exemptions in effect during 1976, an enforcement summary, description of coordination with other Federal Agencies, and recommendations of the National Transportation Safety Board.

Department of Transportation

Rept. No. AR-7; 1977; 122p

Availability: GPO Stock No. 050-000-00132-6

HS-021 497

### SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT

Guidelines are given as to the choice of traffic controls for severe weather conditions caused by dense fog, smoke or dust, snow and ice, preferential icing (as of bridge decks), high winds, flooding, and mudslides. A methodology is presented for estimation of the extent of the hazard and for estimation of the probable benefits of a given traffic control measure. Techniques are given for selection of traffic control measures that best use available funds. Logistical solutions relying on coordination of highway and enforcement agency resources to initiate and manage traffic control measures are usually better than hardware-oriented approaches. Hazard identification involves identifying priority locations via plotting of incidence data, computation of incident rates, statistical comparison of adverse and nonadverse incident rates, and estimation of accident and travel delay costs. Identification of alternative control measures takes into consideration the applicability to site-specific or general traffic controls, appropriateness of traffic control in reducing the hazard, and the potential of the control to achieve the desired motorist response. Costs are determined

february 28, 1978

HS-021 500

by locating the delay, averaging daily traffic volume, noting the number of lanes in the direction of flow, and the traffic density by vehicle class. Costing factors include initial, set-up, annual operating, and maintenance costs. Calculation of average delay per vehicle involves determining controlled flow through a site, selected route diversion, and route closure and diversion. Selection of a delay-reducing traffic control is based on delay time as the unit of effectiveness and a ratio of incremental cost to incremental effectiveness. Types of data needed for determining the effectiveness of a traffic control measure include environmental conditions, accidents, delays, costs, and traffic volume. Worksheets are presented for the various calculations the traffic engineer must make. Appended are illustrative traffic control measures and an extensive, annotated bibliography arranged under the following categories: debris and hazardous materials; dust; floods; fog and visibility; general weather conditions; ice and snow; wind; motorist advisories and traffic control; police and road service patrols; and traffic flows and delays.

by R. J. Rourke; J. J. Bode; P. Jeya  
Arthur Young and Co., 1025 Connecticut Ave., Washington,  
D.C. 20036  
Contract DOT-FH-11-8779  
Rept. No. FHWA-RD-77-70; AY-51-201-801; 1977; 215p  
275refs

Availability: NTIS

HS-021 498

#### INVOLVING CITIZENS IN METROPOLITAN REGION TRANSPORTATION PLANNING. 1977 FINAL REPORT

General observations are made about citizen participation in metropolitan regional transportation planning based on experience in the metropolitan areas of Tucson, Ariz., Minneapolis-St. Paul, Minn., San Francisco, Calif., Miami, Fla., Raleigh, N.C., and Harrisburg, Pa. Various methods were used effectively; the only constants were such attitudinal characteristics as openness, responsiveness, and commitment to the idea of participation. Those who are trying to increase the effectiveness of their citizen participation program should be willing to redefine the nature of the traditional systems planning process, and to change their previous requirements about the kinds of products that should come out of that process. Emphasis on the concept of multiple publics is not particularly important; the key task is eliciting participation rather than identifying participants. It is normal for the level of participation to vary according to the occurrence of major issues and decisions. It is not necessary to assert that participants are strictly representative of the community in order to legitimate the participation process. The general public rather than the community leaders should be the target of participation efforts. Although the structured approach is usually more effective, meaningful community participation also occurs in more fluid, unstructured patterns of communication. The report includes sections on redefining traditional conceptions of systems planning, identifying multiple publics, structuring the participation process, and the benefits of an effective citizen participation program. Appended are descriptions of the study regions and bibliographies relevant to each study area.

Parsons, Brinckerhoff, Quade and Douglas, Inc., One Penn Plaza, 250 W. 34th St., New York, N.Y. 10001  
Contract DOT-FH-11-8845  
Rept. No. FHWA/SES-77/11; 1977; 171p 185refs  
Availability: Federal Hwy. Administration, Socio-economic Studies Div., Washington, D.C. 20590

HS-021 499

#### DEVELOPMENT OF GLASS FIBER TIRE CORD

The primary research and development task in the manufacture of glass fiber tire cord has been to define a total glass fiber reinforcement system, including sizes (coatings) and impregnants, which can achieve maximum use of the inherent high strength and modulus, and low elongation of the glass cord. The three major operations in this manufacturing process are forming, impregnation, and fabrication of the cord. The major ingredients of a typical borosilicate glass used for tire cord are oxides of silicon, aluminum, boron and calcium, most of which are found in abundance in the earth's crust. Glass is formed into continuous filaments by a process similar to that used for synthetic fibers: by extrusion of molten glass through a "bushing," followed by quenching to solidify the glass, coating, and winding. A key part of glass cord manufacture is coating, which protects the fiber from mechanical abrasion and provides coupling of the inorganic glass fiber to the organic matrix in which it will be imbedded. The impregnant system, beside preventing filament abrasion, provides a smooth transition of properties from the high-strength, high-modulus glass filaments to the surrounding low-modulus rubber matrix. The rate of reaction with the rubber compound is critical, properties such as molecular mobility, functionality, and reactivity being specifically tailored to create optimum conditions. In the last step of manufacture, two or more impregnated bundles of filaments are twisted to form the finished tire cord. Among the more fundamental properties which determine whether a material will function adequately as reinforcing cords in belts for radial tires are strength, modulus, and the ability to resist deformation. Other properties important in tire building and in road service are adhesion, cord integrity, and tack. Failure of radial tires in road service can be due to separation at belt edge (the dominant cause), reinforcing cord breakage and tread separation off belt. Fiberglas belted radial tires show superior resistance to belt edge separation. Tests designed to predict performance of radial tires include those involving repeated chilling of the tire to a low temperature and driving over a typical city route. Studies of the mechanism by which glass fiber tire cord may break indicate that cords deform when lateral loads are imposed. In service tests over a city driving route in New Haven, Conn., conditions were monitored with an instrumented vehicle in order to characterize the applied forces and to identify those most abusive to the tire. Instruments monitored the vertical, lateral, and longitudinal forces at all four wheel ends, the steering angle and the vehicle speed. Future developments may include glass reinforcements for the tire carcass as well as the belts, subject to the economics of competitive material.

by Dennis R. Barber; Robert C. Doban  
Publ: Elastomerics v109 n10 p51-4 (Oct 1977)  
1977

Availability: See publication

HS-021 500

#### WHEN STATISTICS AREN'T QUITE NORMAL

Statistical analysis based on normal distribution theory is used frequently, even when characteristics of the variables are known to deviate from normal distribution. The errors introduced are examined for two particular nonnormal distributions. Use of normal theory analysis should be questioned when it is not possible for the variable of interest to attain values below (or above) some point, especially one near the

mean, or when values the same distance above or below the mean or mode are not equally likely. Line graphs are presented showing a comparison of normal and truncated normal distribution and differences in probabilities that a random variable falls within plus or minus standard number of deviations (C) of the mean in the truncated normal compared with normal distribution. Similarly, log normal and normal distributions are compared graphically with differences in probabilities that a random variable falls within plus or minus C standard deviations of the mean compared in each case. With positive values for the percent of difference in probabilities (E1), an assumption of normality in both of the above cases will result in underestimation of the probability. When a distribution is symmetric, as is normal distribution, an interval centered at the mean contains a greater amount of the population than any other interval of the same width. This is not true when the mean and mode do not coincide. In graphs corresponding to those described above, it is illustrated that at positive values for percent of difference in the probabilities (E2) and larger values for C, more area is within plus or minus C standard deviations of the mean than of the mode.

by Russell G. Heikes

Publ: Industrial Engineering v9 n10 p40-3 (Oct 1977)  
1977

Availability: See publication

HS-021 501

#### ELASTOMERIC USE IN 1978 AUTOS

Significant auto industry developments related to elastomers are evident in 1978 model vehicles. General Motors (GM) features a high-pressure spare tire weighing less than half as much as a conventional one, and new front and rear bumper systems containing mostly elastomeric material to reduce weight by up to 100 lbs. Diesel engines designed for an Oldsmobile car and a Chevrolet pick-up truck also feature use of elastomers as a firewall sound barrier and as under-hood insulation. Ford's new compact cars introduce new elastomeric material, including paint. There is also a new design in bushings, "voided" types, for filtering out tire noise. Chrysler is using a hard plastic on the exterior of a new model. Vibration welding is used at Chrysler to combine two items under the hood into one lighter and less expensive unit. RTV silicone valve cover gaskets are being used more widely and one Chrysler engine features a change in silicone jacketed spark plug wire usage. Use of elastomers in bumpers and foam rubber in carpets have reduced vehicle weight. American Motors (AMC) introduced a "soft feel" vinyl upholstery and distinctive plastic add-on items. The AMC Concord uses elastomers for a better, quieter ride and such applications as fill covers for a new antimony battery. GM elastomer bumpers have a damage resisting flexible outer skin of reaction injection molded urethane, backed by a plastic cellular energy absorber which compresses on impact and returns to original shape. GM mid-size cars are providing tests of market acceptance of elastomers as major exterior panel components, as well as body mounts and suspension bushings. Epichlorohydrin is used in Ford Fairmont and Mercury Zephyr cars in the rear exhaust pipe hanger and the rear engine mount for heat resistance and sound absorption, although it is 50% more costly. Ethylene acrylic rubber, "Vamac," another more costly material, is used as insulator between the steering column housing and the instrument panel in Fairmonts and Zephyrs. "Vamac" is preferred by Ford for its heat and sound absorbing qualities and by Chrysler for its high flexibility at

low temperatures and resistance to oil swell and abrasion. Fairmonts and Zephyrs also feature a malleable gum urethane pin insulator in their new disc brake design, a steering column boot of vinyl rubber, an EPDM dust shield for the McPherson strut front suspension, and a graphite-filled Teflon seal on the steering unit. Reaction injection molding is thought likely to replace EPDM in the future. Chrysler is expanding usage of snap-in carboxylated nitrile rubber plugs for car and truck rear axle lub filler ports to reduce the chance of leakage. Chrysler has also expanded use of formed-in-place RTV silicone valve covers except for high performance fleet use. Chrysler continues to use upper cooling system hoses reinforced with DuPont's Kevlar (Fiber "B") for greater strength in extreme temperatures, in spite of increased cost. Increased use of computer controlled spark advance ("lean burn") will increase the amount of silicone potting compound in the computer box to encapsulate parts and circuitry. Higher priced silicone-jacketed ignition wire has been increasingly used for durability under higher secondary voltage and hotter temperature conditions. Lightweight plastic bumper guard cushions and nerf strips are used to save weight, and front wheelhouse plastic splash shields provide vehicle corrosion protection. It is estimated that Chrysler's 1978 model car lines contain over 600 plastic parts. Replacement of wood strips by RIM urethane woodgrain three-dimensional moldings, and a switch from RIM to thermoplastic urethane in "C" pillar covers are features of new station wagon styling which result in weight reduction.

by Anthony Grey

Publ: Elastomerics v109 n10 p23-32 (Oct 1977)  
1977

Availability: See publication

HS-021 502

#### REPORT TO THE PRESIDENT ON COMPLIANCE WITH THE 55 MPH SPEED LIMIT

Highway speeds, after dropping significantly in 1974, and remaining at 1974 levels in 1975, are gradually increasing. In 1976, the average speed of free-flowing vehicles was 58.0 mph on rural interstate highways, and 56.0 mph on urban interstates, as compared to 57.6 mph and 54.7 mph respectively for 1975. A significant portion of motorists violate the 55 mph speed limit: vehicles exceeding 55 mph by state during the first half of 1977 ranged from 30.5% to 77%, and vehicles exceeding 60 mph ranged from 7.5% to 40%. Highway deaths increased from 46,011 in 1975 to 46,820 in 1976, the first fatality increase since enactment of the 55 mph speed limit. The 55 mph speed limit saved at least 1 billion gallons of gasoline in 1975. If all motorists observed the speed limit, some 73 million barrels or more than 3 billion gallons of gasoline would be conserved annually. Public support for the speed limit, as reflected in public opinion polls, is high, even as observance decreases. State enforcement officials support the 55 mph program, but indicate a need for additional financial assistance and technical support, as well as expanded public information and political support. Performance standards against which to measure state enforcement of the 55 mph speed limit should be developed. The following actions would improve the Federal 55 mph program. An aggressive, long-term public information and education program should be implemented which is designed to achieve increased voluntary motorist compliance. The Federal commitment to the speed limit should continue to be through speaking platforms and discussions with state officials; steps should be taken to assure that Federal employees and vehicles are in compliance with the

speed limit. Federal funding assistance should be dedicated for state enforcement. It is recommended that the Administration include within the surface transportation program to be submitted to the Congress a dedicated allocation of \$30 to \$50 million within the National Hwy. Traffic Safety Administration program structure in order to assure continuity of funding for the agencies which must hire personnel to conduct the enforcement program. Authority from Congress should be requested to establish Federal 55 mph compliance standards, to be based on a graduated schedule for achieving an ultimate goal of 85% compliance with the 55 mph speed limit by 1982. Federal technical assistance to states to improve enforcement should be provided.

by Brock Adams  
Dept. of Transportation, Washington, D.C. 20590

1977; 44p

Incorporates a report to the Secretary of Transportation by Benjamin O. Davis, Jr., Special Assistant to the Secretary of Transportation on the 55 mph Speed Limit.

Availability: Corporate author

HS-021 503

#### DYNAMIC ANALYSIS OF MACHINERY VIA PROGRAM DYMPC

The Dynamics of Machinery (DYMPC) computer program finds, at specified time intervals, displacements, velocities, and accelerations in planar machinery subjected to forces of a virtually unrestricted nature. The user may specify the motion of any of the parts of the system and may prescribe general relationships between the motions of different points in the system. The language used is Fortran IV. Equations of motion are generated using the d'Alembert-Lagrange method. Procedures are given for the modeling of the mechanism, modeling of active forces, springs, and dampers, and for modeling motion generator constraints. Simulation of an automobile traveling over a rough road is performed as an example. The user may obtain plots, punched cards, tapes, or additional calculations by further processing of the output data. The presence of gears and cams can be accommodated in the current version of DYMPC.

by B. Paul  
University of Pennsylvania, Mechanical Engineering and Applied Mechanics Dept.  
Grant NSF-Eng72-04070-A02  
Rept. No. SAE-770049; 1977; 14p 11refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 504

#### 1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4

Eight impact tests were made of each of seven U.S. and two foreign vehicles at velocities of from 5 to 15 mph. The vehicles included 1976 models of the Chevrolet Impala, Ford LTD, Plymouth Gran Fury, Chevrolet Vega, Ford Pinto, American Motors Gremlin, Chevrolet Chevette, and Volkswagen Rabbit, as well as the 1975 Honda Civic CVCC. Tests were performed in a laboratory setting with steering and speed control hardware that disengaged just prior to impact. Front passenger compartment floor pan accelerations were recorded in the impact axis for both moving and parked vehicles. Impact veloci-

ties were recorded through a six foot speed trap with a one microsecond timer. The following test modes were used: 4.9 mph front/angled barrier, front/barrier, and rear/barrier; 10 mph front/barrier, front/rear (intervehicular), front/side (intervehicular), and front/angled barrier; and 15 mph front/barrier. Test performance and vehicle damage were recorded by still and motion pictures. Appraisers made estimates of repair costs following the crashes. Permanent crush measurements were made manually. An auxiliary fuel system was used. For each moving vehicle the engines were running and transmissions were in gear; for the parked vehicles in the intervehicular tests, transmissions were in neutral and the engines running. A general description is appended of the facilities and equipment of the laboratory in which the tests were performed.

General Environments Corp., Hartwood, Va. 22471

Rept. No. GEC-5191-Vol-1; 1976; 62p

See also HS-021 504--HS-021 508. Testing conducted for the Insurance Inst. for Hwy. Safety. Appraising subcontracted to Power Appraisal Service, Inc., affiliate of Independent Automotive Damage Appraisers (IADA).

Availability: Reference copy only

HS-021 505

#### 1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B

Standard and optional equipment of each car tested in the 1976 Low-Speed Crash Test Program is listed, as well as base cost, options costs, destination charge, and total cost. Series A vehicles include a Chevrolet Impala, Ford LTD, and Plymouth Gran Fury. Series B vehicles include a Chevrolet Vega, Ford Pinto, and American Motors Gremlin. Series C vehicles include a Chevrolet Chevette, a Volkswagen Rabbit, and Honda Civic CVCC. All models are 1976 except for the Honda which is 1975.

General Environments Corp., Hartwood, Va. 22471

Rept. No. GEC-5191-Vol-2; 1976; 74p

See also HS-021 504, HS-021 506, HS-021 507, and HS-021 508. Testing conducted for the Insurance Inst. for Hwy. Safety.

Availability: Reference copy only

HS-021 506

#### 1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C

Accelerometer recordings are presented for each test in the 1976 Low-Speed Crash Test Program. In each test, channel one was located on the left front floor pan and channel two was located on the right front floor pan. Channels three and four were used only for intervehicular crashes with channel three located on the left front floor pan and channel four on the right front floor pan. Channels one and two were always located on the impacting vehicle while channels three and four were used with the struck vehicle.

General Environments Corp., Hartwood, Va. 22471

Rept. No. GEC-5191-Vol-3; 1976; 79p

See also HS-021 504, HS-021 505, HS-021 507, and HS-021 508. Testing conducted for the Insurance Inst. for Hwy. Safety.

Availability: Reference copy only

HS-021 507

**1976 VEHICLE LOW SPEED IMPACT TESTING.  
VOL. 4 OF 4. APPENDIX D**

Repair cost estimates are presented for each vehicle crash performed in the 1976 Low-Speed Crash Test Program. Data provided include the part damaged, repair work needed, labor hours required, and cost of parts and materials.

General Environments Corp., Hartwood, Va. 22471  
Rept. No. GEC-5191-Vol-4; 1976; 100p  
See also HS-021 504--HS-021 506 and HS-021 508. Testing conducted for the Insurance Inst. for Hwy. Safety.  
Availability: Reference copy only

HS-021 508

**1976 VEHICLE LOW SPEED IMPACT TESTING:  
EVALUATION IN THE CONTEXT OF FMVSS 215**

The results of the 4.9 mph tests that were part of the 1976 Low-Speed Crash Test Program are checked against the requirements of Federal Motor Vehicle Safety Standard (FMVSS) 215, Exterior Protection, Passenger Cars. That standard requires that passenger cars manufactured after 1 Sep 1973 withstand 5 mph front and rear impacts into a barrier without damage to safety related components and systems. The following vehicles were tested: Chevrolet Impala, Vega, and Chevette; Ford LTD and Pinto; Plymouth Gran Fury; American Motors Gremlin; Volkswagen Rabbit; and Honda Civic CVCC. Models were 1976 except for the Honda which was 1975. Appended data include window sticker descriptions and the completed test checklists of each vehicle. The left rear turn signal lens of the Volkswagen Rabbit appeared not to satisfy the protective criteria specified in FMVSS 215.

General Environments Corp., Hartwood, Va. 22471  
Rept. No. GEC-5191.1; 1976; 59p  
See also HS-021 504--HS-021 507. Testing conducted for the Insurance Inst. for Hwy. Safety.  
Availability: Reference copy only

HS-021 509

**1977 VEHICLE LOW SPEED IMPACT TESTING.  
VOL. 1 OF 4**

Three impact tests were made of each of 12 U.S. and four foreign vehicles at velocities of 5 and 10 mph, with one additional test performed of five of the U.S. vehicles. The following vehicles were used: Ford LTD, LTD II, Granada, and Pinto; Plymouth Gran Fury and Volare; Chevrolet Impala, Chevelle, Nova, Vega, and Chevette; American Motors Gremlin; Datsun B210; Volkswagen Rabbit; and Honda Civic CVCC. Tests were performed in a laboratory setting with steering and speed control hardware that disengaged just prior to impact. Accelerations and decelerations of front passenger compartment floor pans were recorded in the impact axis for both moving and parked vehicles. Impact velocities were recorded through a six foot speed trap with a one microsecond resolution timer. The following test modes were used: 4.9 mph, front/angled barrier; 10 mph, front/rear (intervehicular), front/angled barrier, and front/barrier. Test performance and vehicle damage were recorded by still and motion pictures. Appraisers made estimates of repair costs following the crashes. Permanent crush measurements were made manually. An auxiliary fuel system was used. For each moving vehicle

the engines were running and transmissions in gear for the 10 mph tests and in neutral for the 4.9 mph tests; transmissions of the parked vehicles were in neutral and the engines running. A general description is appended of the facilities and equipment of the laboratory in which the tests were performed.

General Environments Corp., Hartwood, Va. 22471  
Rept. No. GEC-5348-Vol-1; 1977; 59p  
See also HS-021 510--HS-021 512. Appraising subcontracted to Power Appraisal Service, Inc., affiliate of Independent Automotive Damage Appraisers (IADA). Testing conducted for the Insurance Inst. for Hwy. Safety.  
Availability: Reference copy only

HS-021 510

**1977 VEHICLE LOW SPEED IMPACT TESTING.  
VOL. 2 OF 4. APPENDIX B**

Standard and optional equipment of each car tested in the 1977 Low-Speed Crash Test Program is listed, as well as base cost, options costs, destination charge, and total cost. The vehicles tested are the following: Ford LTD, Plymouth Gran Fury, Chevrolet Impala, Chevrolet Chevelle, Ford LTD II, Chevrolet Nova, Ford Granada, Plymouth Volare, Chevrolet Vega, Ford Pinto, American Motors Gremlin, Chevrolet Chevette, Toyota Corolla, Volkswagen Rabbit, Datsun B210, and Honda Civic CVCC. All models are 1977 except for the Honda which is 1976.

General Environments Corp., Hartwood, Va. 22471  
Rept. No. GEC-5348-Vol-2; 1977; 57p  
See also HS-021 509, HS-021 511, and HS-021 512. Testing conducted for the Insurance Inst. for Hwy. Safety.  
Availability: Reference copy only

HS-021 511

**1977 VEHICLE LOW SPEED IMPACT TESTING.  
VOL. 3 OF 4. APPENDIX C**

Accelerometer recordings are presented for each test in the 1977 Low-Speed Crash Test Program. In each test, channel one was located on the left front floor pan and channel two was located on the right front floor pan. Channels three and four were used only for intervehicular crashes with channel three located on the left front floor pan and channel four on the right front floor pan. Channels one and two were always located on the impacting vehicle while channels three and four were used with the struck vehicle.

General Environments Corp., Hartwood, Va. 22471  
Rept. No. GEC-5348-Vol-3; 1977; 58p  
See also HS-021 509, HS-021 510, and HS-021 512. Testing conducted for the Insurance Inst. for Hwy. Safety.  
Availability: Reference copy only

HS-021 512

**1977 VEHICLE LOW SPEED IMPACT TESTING.  
VOL. 4 OF 4. APPENDIX D**

Repair cost estimates are presented for each vehicle crash performed in the 1977 Low-Speed Crash Test Program. Data pro-

vided include the part damaged, repair work needed, labor hours required, and cost of parts and materials.

General Environments Corp., Hartwood, Va. 22471  
Rept. No. GEC-5348-Vol-4; 1977; 73p  
See also HS-021 509--HS-021 511. Testing conducted for the  
Insurance Inst. for Hwy. Safety.  
Availability: Reference copy only

HS-021 513

### UNDERSTANDING ENGINES. SUCK, SQUEEZE, POP, PHOOEY

The mechanical parts of contemporary automotive engines are described as converting heat from gasoline or diesel fuel to rotary motion, either by reciprocating engine or by rotating combustion chamber. Criteria for engine efficiency include fuel consumption, power delivered, durability and driveability, such as throttle response and starting behavior. The conversion of heat energy into usable power is accomplished in a four-stroke cycle: intake, compression, ignition, and exhaust ("suck, squeeze, pop, phooey"). The most common type of automobile engine is the American V-8; its principal advantages are smoothness, quietness, and long term durability with minimal maintenance. The weight and durability result in poor fuel economy. European and Japanese engines are smaller, lighter, more mechanically complex, operate at higher engine speeds, use less fuel, tend to require more service and tend to be less durable. European and Japanese engines may have single or double overhead camshafts, eliminating the push rod and resulting in greater mechanical efficiency and reduced valve train weight, both of which aid continuous high speed operation. Other variations of the piston engine include various stratified charge engines, as in the Honda CVCC, in which two combustion mixtures are ignited in separate chambers. One important benefit of this engine is meeting emission standards without a catalytic converter; another is the ability to use regular gasoline. The emission level does not deteriorate as in engines with chemical catalysts. Diesel engines, in spite of cheaper operation, have always been unsatisfactory in cars, due to the difficulty of finding fuel and, with the exception of the Mercedes 300D, slow acceleration. Diesel engines are durable, more efficient, and have lower carbon monoxide and hydrocarbon emissions; they emit high levels of nitrogen oxides, exceeding the proposed limit of 0.4 g/mi. The diesel engine's reputation for durability is due to its heavy duty application and to meticulous maintenance by owners who prefer diesels. The rotary engine, invented by Felix Wankel in Germany, is a four stroke rotating combustion chamber system with the advantages of small size for its power output, quiet and smooth running, and durability (in the Mazda development). Rotary engines have low nitrogen oxide emissions and their thermal reactor emission control systems clean up hydrocarbon and carbon monoxide emissions, eliminating the performance deterioration due to chemical catalysts. Mazda has developed two forms of emission control: Rotating Stratified Combustion (ROSCO) and Compound Inductions Step Control (CISC). Of all the engines described, the rotary seems to offer the most future promise, since it is small, light, economical, and powerful.

by Don Fuller  
Publ: Road Test v13 n6 p34-9 (Jun 1977)  
1977  
Availability: See publication

HS-021 514

### DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS

An analytical simulation is made of a road simulator test in which the reaction forces and moments at the front suspension bearings and displacements at various locations on the vehicle are computed. The three-dimensional mathematical model upon which the analysis is based has three-dimensional front suspension geometry which is treated as an integral part of the complete vehicle analysis. The loop closure constraints of the front suspension system are superimposed on an unconstrained system where the body is connected to the ground by tires and springs. The equations of motion are obtained by the generalized d'Alembert force technique. The simulations made were of a vehicle with one of its front wheels going over an irregular road surface, using a harmonic displacement curve to approximate the road surface. Variations in amplitude and frequency of the input sinusoidal curve serve to simulate different road profiles and vehicle speeds. Both low frequency runs and high frequency runs are graphed. Most of the computing time is for developing algebraic equations in which the variables are the dependent accelerations, developing the LaGrange multipliers, solving the equations, and integrating the accelerations.

by Y. O. Bayazitoglu; M. A. Chace  
Brown and Root, Inc.; University of Michigan  
Rept. No. SAE-770051; 1977; 8p 9refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 515

### NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS

A three degree of freedom mathematical model formulation for a double-wishbone front suspension is presented which treats the effects of the tire vertical stiffness, the fore and aft bushing compliance in the lower arm, the compliance in a steering linkage, and the inertia of the suspension links. The model equations are derived, retaining all nonlinearities associated with large changes in the geometric configuration of the suspension force and displacement response to prescribed ground terrain inputs at the tire patch. Comparison of results of the computer model with test measurements shows generally close agreement. The fore/aft force history predictions show the least agreement with experimentation because of the oversimplification used in the model which constrains motion of the lower arm to one rotation and a deflection along its pivotal axis and that of the upper arm to one rotation. The model is suitable for predicting vertical force input in a variety of simulated road terrains, and for estimating loads information useful for vibration and stress analysis studies.

by Kenneth N. Morman, Jr.  
Ford Motor Co.  
Rept. No. SAE-770052; 1977; 16p 1ref  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

## HS-021 516

**SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM**

The front suspension of a 1973 Chevrolet Malibu is simulated by computer using the Automatic Dynamic Analysis of Mechanical Systems (ADAMS) program in order to evaluate the speed, economy, and accuracy by which the program predicts displacements and loads. ADAMS uses either Fortran IV and IBM 360/370 or just Fortran IV, and six generalized coordinates for each body. It is capable of static analysis, large displacement or nonlinear transient analysis, and small displacement or linearized analysis around a static solution or at any solution point in time, including vibrational analysis, modal analysis, modal sensitivity, and modal optimization. Comparison of simulated with experimental loads shows substantial disagreement due to linear approximations of forcing effects, neglect of friction, representation of the elastic bushings as ideal joints, and difficulty in excluding various practical effects.

by N. Orlandea; M. A. Chace  
Deere and Co.; University of Michigan  
Grant NSF-GK-31800  
Rept. No. SAE-770053; 1977; 15p 10refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

## HS-021 517

**A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES**

The UMVCS-1 computer program, based on a modular concept, was developed for simulation of vehicle crash. For a given simulation the user specifies the vehicle through an alphanumeric physical description of the model. Input is translated and the necessary equations assembled for the mathematical model. Storage assignment and dimensioning are all handled internally in the program. Modeling elements include both finite element beams and mechanisms which are three-dimensional generalizations of resistances commonly used in one-dimensional simulations. An example is a modeling of an actual barrier test in which a 1968 Plymouth Fury was frontally impacted at 30 mph; the vehicle's forward sheet metal, radiator, grille, and engine had been removed. Comparison of simulation and test results shows that there is relatively good agreement over the first half of the crash duration. A marked increase in barrier force around 70 ms reflects interaction of the front tire and suspension system with the barrier. The simulation appears to give good results in predicting average values, but is less satisfactory in predicting frequency content and peak values. The problem may lie in treating the passenger compartment as a rigid body; however, the simulation does seem to predict the dynamic force deformation characteristics of the vehicle structure.

by Ivor K. McIvor  
University of Michigan  
Contract DOT-HS-4-00855  
Rept. No. SAE-770054; 1977; 12p 9refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

## HS-021 518

**COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS**

A two-dimensional Lagrangian explicit finite difference (EFD) computer program called STEALTH simulates three large deformation dynamic tests: the Charpy V-notch impact toughness test, oblique impact of a cylindrical rod on armor plate, and driving of copper liners by a shaped, high explosive charge. Calculations are done by the HEMP computer program. Comparison of EFD with the more recently developed explicitly finite element (EFE) formulation shows that the principal difference lies in the calculation on the internal forces. A uniaxial tension test simulation is run on nuclear pressure vessel steel; correlation of data with tests is very good. The Charpy V-notch impact toughness test is demonstrated by a simulation of elastic work hardening plastic with a uniaxial flow-stress specification, modeled in a three-point bend configuration with the load applied by the flying striker. Simulation of a cylindrical rod impacting obliquely (attack angle of 65°) on rolled homogeneous armor steel describes the rod and target material behaviors by elastic/plastic work hardening constitutive models in which dependence of the shear modulus and yield strength is given as a function of the equivalent plastic strain, compression, pressure, and internal energy. Deformation calculations are made of a nickel cone surrounded by explosives and placed inside a cylindrical steel shell (shaped charge liner). All calculations were done on the CDC 7600 computer, and all data contained in core.

by D. M. Norris; M. van Thiel; B. Moran  
University of California, Lawrence Livermore Lab.  
Contract ERDA-W-7405-Eng-48  
Rept. No. SAE-770055; 1977; 12p 11refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977. Partially supported by Electric Power Res. Inst., Advanced Res. Projects Agency, and the Ballistics Res. Lab.  
Availability: SAE

## HS-021 519

**KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES**

New kinematical relationships occur in the analysis of certain motions of single-track vehicles when the factor of slip is added to the rolling motion. Constraint equations are formulated for motions involving side slip unaccompanied by longitudinal slip, expressions for side slip velocities are developed, and comparisons are drawn between the kinematical consequences of assuming rolling without slip and rolling with side slip.

by Thomas R. Kane  
Stanford Univ., Dept. of Mechanical Engineering  
Rept. No. SAE-770056; 1977; 8p 3refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977. See also HS-021 520.  
Availability: SAE

HS-021 520

**STEADY TURNING OF SINGLE-TRACK VEHICLES**

Steady turning of single-track vehicles is examined by reference to dynamical equations applicable when rolling takes place without slip. In formulating these equations, advantage is taken of the fact that one may linearize in the steering angle without restricting the turning radius. This makes it possible to arrive at equations which permit one to obtain both numerical results and general insights rather easily. A table shows the possible relationships among and interdependence of steering angle, steering torque, rear wheel rotation rate, roll angle, lateral rider mass center displacement, and turning radius.

by Thomas R. Kane

Stanford Univ., Dept. of Mechanical Engineering

Grant NSF-ENG-75-18680

Rept. No. SAE-770057; 1977; 11p 4refs

Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977. See also HS-021 519.

Availability: SAE

HS-021 521

**VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION**

The state of the art of correlation and validation of mathematical crash victim simulators is described, with particular reference to the recently developed Validation Control Language (VCL) software. VCL features graphical output capability and a command language in simple English words with the following divisions: identification, assessment, preparation, comparison, and presentation. It can manipulate, analyze, and compare dynamic impact data, simplify quantitative validation of mathematical models, and demonstrate correlation between experiments and/or theoretical estimates. Most attempts at validation have served primarily as demonstrations of model predictive capability. No statements stronger than "reasonable correlation" or "some level of confidence" are made since the deductions have been based on qualitative comparisons. Experimental and analytical work should be done on the validation process before any testing is done. The validation process can aid in understanding the physical event due to the ability of the model to predict information which was not measurable in the experiment. To provide a quantitative basis for model validation, it is necessary to assemble or develop data processing software such as the VCL which includes response measures and means for their comparison. Response measures such as head injury criterion, severity index, and areas under curves have limited value in validation since their values are not unique to a particular waveform. The validation process should incorporate the following tasks: matching the model with the physical event; selecting indicators of correlation; choosing acceptable levels of correlation; designing the experiment and choosing model input; conducting the experiment and exercising the model; processing data and computing correlations; and making decisions on model validity. Standard, common practices should be developed for response measures, indicators of correlation, the means by which decisions are

made as to model validity, and the reporting of validation exercises.

by D. H. Robbins; R. O. Bennett; J. M. Becker

University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich.

Rept. No. SAE-770058; 1977; 21p 17refs

Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.

Availability: SAE

HS-021 522

**TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST**

Systems for controlling automotive exhaust particulates, especially lead particulates, are discussed and a suitable method for determining automotive particulate emission levels during on-the-road vehicle operation is presented. A Particulate Performance Evaluation Filter consists of glass microfibers bonded with a stable organic resin, installed in a stainless steel housing mounted on an automobile's trunk lid and connected to the car's tail pipe by a teflon-lined flexible silicon hose. Use of this filter in on-the-road tests is thought to provide more accurate measurement of exhaust particulates than chassis dynamometer tests, since underbody cooling of vehicles on the road lowers the temperature affecting lead particulate emission. Data are presented for a large number of vehicles. The evaluation system is suited for use with a large variety of vehicles during all modes of vehicle operation. A total emissions control system, capable of meeting the strict 1978 statutory gaseous emissions levels with virtually zero particulate emissions, is also discussed. This emissions control system is compatible with leaded and unleaded fuels. The economic implications of lead additive restriction, as a means of reducing lead airborne particulates, are briefly considered. The reduction of airborne lead, by trapping it in the exhaust system, is more cost effective and energy conservative than is reduction by regulation of the fuel supply. Particulate traps coupled with lead-tolerant emission control systems allow this alternative. Engine noise can also be controlled and emission levels of other particulates can be reduced. The Particulate Evaluation Filter provides an easy and effective method for measuring exhaust particulates in all modes of vehicle operation.

by Martin B. Treuhaft; John P. Wisnewski

Southwest Res. Inst., Dept. of Engine and Vehicle Res.; PPG

Industries, Inc., Houston Chemical Co.

Rept. No. SAE-770059; 1977; 23p 27refs

Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.

Availability: SAE

HS-021 523

**EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS**

Materials having a potential for use as on-vehicle sorbents of sulfate emissions from oxidation catalysts were evaluated using an engine dynamometer screening test procedure. All sorbents showed some undesirable characteristic such as low sulfate trapping efficiency, poor physical strength (bulk sorbents), or low capacity (supported sorbents). The two most promising materials, a bulk calcium oxide and an alumina-supported sodium sorbent, were tested further. The CaO sorbent

appeared to be inherently nonselective between sulfates and sulfur dioxide. Calcining this sorbent in a carbon dioxide atmosphere resulted in increased pellet crush strength and reduced volume expansion upon use. The alumina-supported sodium sorbent had good activity and selectivity, but may lack capacity and may be subject to leaching losses of sodium compounds. Vehicle and dynamometer durability testing of the two sorbents shows that neither met all criteria of an ideal sorbent for vehicle use.

by G. J. Barnes; J. C. Summers; D. R. Fredericks  
General Motors Corp.  
Rept. No. SAE-770060; 1977; 14p 14refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 524

#### IMMUNOLOGICAL STUDIES ON PLATINUM COMPLEXES AND THEIR POSSIBLE RELEVANCE TO AUTOCATALYSTS

Preliminary tests on extracts from exhaust solids support the hypothesis, deduced from skin-prick tests on refinery workers and estimates of the types of platinum compounds likely to be formed, that no allergenic species are emitted. A series of platinum complexes has been used for allergy tests on a number of refinery workers who are known to be sensitive to hexachloroplatinate salts. Hypersensitivity to platinum chloro complexes has been established as Type I or anaphylactic type sensitivity. Skin tests show that allergenicity of platinum complexes is directly related to both their charge and their overall reactivity. The results show that the allergy-eliciting compounds appear to be confined to a very small group of ionic complexes containing reactive halogen ligands. Neutral complexes and those containing strongly bound groups are totally inactive. These variations are discussed in terms of established kinetic and thermodynamic parameters and their relevance to autocatalysts. Results of this study tend to invalidate postulations linking sensitization with short term concentrations of platinum near expressways. Initial tests on aqueous extracts of exhaust particulate matter elicited no response from sensitive people.

by M. J. Cleare  
Johnson Matthey Res. Center  
Rept. No. SAE-770061; 1977; 15p 31refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 525

#### CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES

Approximately 100 consumer-owned, catalyst-equipped vehicles in California, model years 1975 and 1976, were tested for regulated exhaust gas emissions and particulate sulfate emissions. The tests were conducted three times in approximately 11 months with the owners' brands of commercial fuel, which were analyzed for sulfur and lead concentrations, Reid vapor pressure, distillation, and API gravity. Emission data were analyzed to determine possible differences in sulfate and regulated gaseous emission levels between various subgroups of

catalyst-equipped vehicles, and to derive average sulfate emission factors. Pelleted catalysts with and without air injection were tested, as well as monolith catalysts such as U.O.P., Matthey-Bishop, Engelhard, and unknown types. Tests included the 1975 Federal Test Procedure (FTP), and first through fourth S-7 Sulfate Cycle Tests. It was concluded that sulfate emissions from in-use, consumer owned vehicles are significantly lower than previously estimated and that there is a significant reduction in sulfate emissions during the first 12,000 miles of operation. FTP results showed a concurrent increase in carbon monoxide emissions except in Chrysler vehicles equipped with monolith catalysts and air injection. Except for Matthey-Bishop catalysts, which provide substantially lower emission levels of sulfuric acid, monolith and pelleted catalysts emit comparable levels under air injection. Sulfate emissions during the Highway Fuel Economy Test were significantly higher than those for the S-7 driving cycle. Deterioration of hydrocarbon emissions during the first 12,000 miles of operation occurred only in vehicles equipped with pelleted catalysts without air injection and in Fords with Engelhard monolith catalysts and air injection. Nitrogen oxide emissions remained constant during this period, exceeding 1975/76 California standards of 2.0 g/mi. Chrysler automobiles showed significantly higher nitrogen oxide emissions than those of other vehicle/catalyst combinations.

by R. J. Herling; R. D. Gafford; R. R. Carlson; A. Lyles; R. L. Bradow  
Olson Labs., Inc.; Environmental Protection Agency  
Contract EPA-68-02-2232  
Rept. No. SAE-770062; 1977; 16p 14refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 526

#### THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY

Speciation of sulfurous acid, sulfuric acid, and ammonium sulfate collected from the aerosol phase on a Fluoropore filter has been readily accomplished using techniques of chemical ionization mass spectrometry combined with thermal separation. Thermal separation of ammonium hydrogen sulfate from ammonium sulfate was not possible. Spectral separation of these species by selective ionization is proposed. Analysis of sulfate aerosols collected from ambient air and catalyzed vehicle emissions is described. It was found that sulfuric acid aerosol was rapidly converted to ammonium sulfate or ammonium hydrogen sulfate in the presence of ambient concentrations of ammonia. Ambient samples collected in the Detroit metropolitan area have been found to contain only trace quantities of sulfuric acid. Sulfate samples collected from a dilution tube into which catalyzed vehicle exhaust was injected were found to contain significant quantities of ammonium sulfate in addition to sulfuric acid. The rate of sulfate species volatilization from the filter media was found to be markedly affected by the ammonium sulfate particle size on the filter, thus necessitating the generation of appropriate standards. Impregnation of the collection filter with an appropriate material that will convert sulfuric acid upon collection to a species which is unaffected by ambient ammonia concentrations can

permit subsequent quantitation of ambient sulfuric acid by mass spectrometry.

by T. M. Harvey; D. Schuetzle  
Ford Motor Co.

Rept. No. SAE-770063; 1977; 8p 14refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 527

#### EMISSIONS FROM IN-USE CATALYST VEHICLES

A sample of 49 1975 and 1976 catalyst equipped vehicles operated in the Albany, N.Y., area have been tested in "as received" condition for gaseous and particulate emissions at approximately 5000 mile intervals. Each of the 127 tests included a 1975 Federal Test Procedure, a one-hour 50 mph steady cruise, and five Environmental Protection Agency Congested Freeway Driving Schedule Cycles (SET-7 cycles), all run on tank fuel. Test data include hydrocarbon, carbon monoxide, oxides of nitrogen, and sulfur dioxide (HC, CO, NO<sub>x</sub>, and SO<sub>2</sub>), idle HC and CO, soluble particulate sulfate, and fuel economy. Summaries of emission rates are presented as a function of catalyst type, manufacturer, and emission parameters. Specific attention is given to release of stored sulfur during idle periods between test driving modes. Data are also presented on plugged converters found on high mileage police vehicles. This serious plugging appears to be the result of deposition of manganese and oil additive related compounds in monolith cells on cars run on fuel containing MMT (methycyclopentadienyl manganese tricarbonyl) additive. Catalyst vehicles in consumer use frequently exhibit idle CO well above levels corresponding to proper converter operation. Representative SET-7 sulfate emissions from catalyst vehicles without air pumps average 1.3 mg/mi while air-pump equipped vehicles have an average value of 4.9 mg/mi. These results reflect an average fuel sulfur content of 0.017 weight percent. Vehicles with active catalysts and high idle CO yield a marked SO<sub>2</sub> spike upon deceleration to idle conditions. This purge contains very small amounts of particulate sulfate. Significant amounts of fuel sulfur are stored on catalysts. Except for monolith catalysts without air pumps, sulfate emissions during consecutive SET-7 cycles are reproducible after preconditioning by a one-hour, 50 mph steady cruise. For systems with a monolith catalyst without air pump, the preconditioning sequence requires a one-hour, 50 mph steady cruise followed by at least one SET-7 cycle.

by R. Gibbs; G. Wotzak; S. Byer; R. Johnson; B. Hill; P. Werner  
New York State Dept. of Environmental Conservation, Div. of Air Resources  
Grant EPA-R803520-01-0  
Rept. No. SAE-770064; 1977; 39p 28refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 528

#### SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS

The barium ion titration method as used for determining the amount of sulfuric acid and soluble sulfate aerosol emitted by

automobiles is described. Results obtained by this method are compared with those obtained by the barium chloranilate (BCA) method. It is concluded that the described titration method is a low-cost and convenient method for the analysis of automotive derived sulfates. The precision of the method is good, its sensitivity adequate, and its accuracy as good as the BCA method. Its simplicity permits analysis, by one operator, of approximately 35 samples per eight-hour day.

by Arnold Prostak  
General Motors Corp., Milford Vehicle Emission Lab.  
Rept. No. SAE-770065; 1977; 8p 11refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 529

#### ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS

A new approach for improving fuel economy uses computer programs to optimize and tailor an engine's fuel, exhaust gas recirculation, and spark control in the laboratory. The basic approach taken was to describe the engine's response to all possible control combinations and break down its schedule of operation in a vehicle so that a computer program using linear programming could select an optimal control strategy. New forms of engine and vehicle test data were used as inputs. The emission engineer is in control of the process via a special interactive program at a computer terminal. The method was used successfully to improve the fuel economy in a test car equipped with electronic controls, with a gain in fuel economy of 7% over a conventionally equipped and tailored test car. In the optimization procedure, both urban and highway tests are included, as well as a simple simulation of the catalytic converter. Engine mapping data will represent a basic engine for several years until the engine is modified internally; no new theories or technology are required. The programs can also be used to study tradeoffs of optimized fuel economy versus emissions for a vehicle. Although presently limited to warmed up operation, the procedure has proved valid and useful.

by E. A. Rishavy; S. C. Hamilton; J. A. Ayers; M. A. Keane  
General Motors Corp., Chevrolet Engineering; General Motors Res. Labs.  
Rept. No. SAE-770075; 1977; 19p 6refs  
Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.  
Availability: SAE

HS-021 530

#### OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS

A method is presented for determining an optimum engine calibration that maximizes fuel economy for the CVS-H cycle subject to a set of emission constraints. The method combines the results of a powertrain simulation with steady state engine dynamometer emissions and fuel flow data to project cycle emission and fuel economy values. Dynamic programming can be used to determine the optimal allocation policy by selecting an emission and fuel flow at each specified engine speed/load point from a steady state engine dynamometer base. Once the optimal allocation policy is determined, the engine control

variables associated with the selected emission and fuel flow can be obtained directly from the steady state data. A Lagrange multiplier technique can be used to reduce a higher dimensional dynamic programming problem involving multiple emission constraints to a one-dimensional dynamic programming problem involving a single emission constraint and Lagrange multiplier(s). This technique makes it possible to develop a practical computational algorithm by greatly reducing the computer storage penalties associated with higher dimensional problems. Dynamic programming is used to allocate emission contributions among selected speed/load points to maximize projected cycle fuel economy. The corresponding engine calibration is then directly inferred from the optimum emission allocation. Typical results for 2.3 liter and 400 CID engines are presented.

by J. E. Auiler; J. D. Zbrozek; P. N. Blumberg  
 Ford Motor Co., Engineering and Res. Staff  
 Rept. No. SAE-770076; 1977; 19p  
 Presented at International Automotive Engineering Congress  
 and Exposition, Detroit, 28 Feb-4 Mar 1977.  
 Availability: SAE

HS-021 531

#### ENGINE MAPPING METHODOLOGY

A methodology was devised by which projections of emissions and economy can be made for a vehicle driving a prescribed cycle in a fully warm condition. A model of the drivetrain provides a description of the engine operating requirements from which representative conditions are selected. Steady state engine dynamometer data at these conditions are used to make the projections. Optimization programs are available to select calibrations which will best utilize the control systems, exhaust treatment devices, and drivetrain configurations to improve economy at specified emission levels. Optimization is done among the discrete engine test conditions with no restrictions on ability to implement the results. This selects the optimum solution independent of control system limitations. The results define the basic engine hardware capabilities. Exhaust treatment devices can be included by modifying the data according to the characteristics of the device, providing a convenient comparison of the potential of various exhaust treatment systems on the same vehicle. Characterization of exhaust treatment devices during transient operation is not included. Engine preparation, engine monitoring, and test cell environment are important considerations to accurately project vehicle tests. Test procedures, and data acquisition and review must be specifically designed to handle the volume and collection rate of the data. Special techniques are necessary to review the data and retain engineering judgment of acceptable data error tolerances. Implementation of optimum calibrations requires knowledge of control system capabilities as well as engine requirements outside the immediate test range. Alternate calibration schedules can be screened by using the data base and by examining sensitivity to calibration excursions.

by R. E. Baker; E. E. Daby  
 Ford Motor Co., Engineering and Res. Staff  
 Rept. No. SAE-770077; 1977; 16p 3refs  
 Presented at International Automotive Engineering Congress  
 and Exposition, Detroit, 28 Feb-4 Mar 1977.  
 Availability: SAE

HS-021 532

#### A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS

A new engine dynamometer procedure is described which was developed to determine engine calibration for the best possible fuel economy performance at a specified level of emissions performance. In this on-line technique an engine dynamometer minicomputer, programmed with an optimization algorithm, automatically determines the optimum calibrations for spark advance, air-fuel ratio, and exhaust gas recirculation at fixed speed-load operating points. These points are selected by analysis of measured or simulated performance of the engine in a specified vehicle. Provided that emission constraint levels can be specified and reasonably accurate values of the Lagrangian multipliers can be estimated, an optimum calibration can be determined with as little as 18 hours of testing time. Limitations of this method as described include the following. Only hot cycle static data are used; the cold start is treated in a separate fashion. Values of the Lagrangian multipliers must be known or estimated. If major changes are made in the vehicular drivetrain description resulting in significant changes in engine speed-torque requirements or if a wide range of emission constraints must be treated then the on-line approach would have to be repeated. However, small changes can be handled without additional data, since mathematical models of the engine performance, produced as part of the on-line procedure, can be used to resolve the problem. The resulting calibrations must be implemented in a real vehicle to determine transient effects, driveability problems, etc., and to obtain a more realistic estimate of the potential for fuel consumption improvement.

by John F. Cassidy  
 General Motors Corp., General Motors Res. Labs.  
 Rept. No. SAE-770078; 1977; 19p 13refs  
 Presented at International Automotive Engineering Congress  
 and Exposition, Detroit, 28 Feb-4 Mar 1977.  
 Availability: SAE

HS-021 533

#### COMPUTERIZED FIVE PARAMETER ENGINE MAPPING

Systematic and computerized mapping procedures were developed to characterize the performance of an engine as a function of speed, load, ignition timing, air/fuel ratio, and percent of exhaust gas recirculation. Using these techniques a map of a carbureted, 5.7 liter (C.I.), spark-ignited V-8 engine was obtained. This five parameter map data base resides in a large computer system which allows access by multiple users. The mapping procedures combine a rational approach to the selection of speed-load points for engine mapping with a computerized test incorporating a slow sweep of the independent variables with simultaneous data acquisition. When compared to the conventional steady state test procedures (manual or computerized), the spark advance, air/fuel ratio, and exhaust gas recirculation sweep tests produce data of equivalent accuracy and repeatability while providing more comprehensive data with less effort and in much less time.

by Lakshmi S. Vora  
 General Motors Corp., General Motors Res. Labs.  
 Rept. No. SAE-770079; 1977; 15p 8refs  
 Presented at International Automotive Engineering Congress  
 and Exposition, Detroit, 28 Feb-4 Mar 1977.  
 Availability: SAE

HS-021 534

**WHAT COMES NEXT IN AUTO SAFETY?**

By the mid 1980's, when the recently established fuel economy and passive restraint standards have resulted in safer and more economical automobiles, the work of the National Hwy. Traffic Safety Administration (NHTSA) will just be beginning. Areas of continuing interest include development of such alternative power plants as the turbine or Stirling engine, new materials to provide weight reduction with crashworthiness, pedestrian fatalities, motorcyclist and cyclist fatalities, and automobile/truck collisions. Predicted trends in highway safety include reduction of injuries and deaths among vehicle occupants, fewer fires in vehicle crashes, and increased injuries and deaths for occupants of vans, light trucks, and multipurpose passenger vehicles. NHTSA research has concentrated on frontal crashes involving automobiles. Studies show that sides of large and small cars alike are weak, but that relatively simple modifications can greatly strengthen crashworthiness. Research safety vehicles designed by Calspan and Minicars, for example, provide protection from impact of a 3000 pound car at speeds in excess of 45 mph via such design features as increased door strength, improved hinges and door pins, increased interior padding, and use of passenger seats as structural members. Automobile manufacturers are reluctant to make technological changes, but experience shows that the industry could reestablish itself as a growth industry by taking advantage of the technological possibilities that exist to improve fuel economy or safety. A possible future trend is the merging of mass transit with the private automobile in such novel systems as automated highways and autopilots for automobiles.

by Joan Claybrook

National Hwy. Traffic Safety Administration

1977; 12p

Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.

Availability: Reference copy only

HS-021 535

**MINICARS RSV BRAKE SYSTEM**

The service brake and collision mitigation systems of the Minicars Research Safety Vehicle (RSV), Phase 2, were designed and costed. Performance objectives were the following: no degradation of performance with the antiskid operational for dry, wet, or slippery road surfaces; vehicle stability during braking in a turn; meet or exceed requirements of Federal Motor Vehicle Safety Standard (FMVSS) 105-75; and minimizing weight of brake system hardware. The system chosen was the full hydraulic, four wheel disc, four wheel antiskid braking system. Possibilities considered but rejected for the collision mitigation system included solid propellant rocket thrusters, negative hover, aerodynamic devices such as spoilers or negative lift wings, high friction pads, and underside air bags. The collision mitigation system, intended to substantially reduce impact speeds in collisions which are not avoidable by driver action, was designed and tested in a prototypal vehicle. A stopping distance of 131 ft can be achieved from 60 mph. The collision mitigation system uses automatic rapid service brake application and causes peak braking forces to be developed within approximately 8 ft after receipt of a signal, when the vehicle is traveling at 50 mph. For a stationary target, rear impact speeds may be reduced to approximately 14 mph from an initial speed of 50 mph by

using the collision mitigation system. The cost of the brake system hardware is estimated at \$286 when an annual mass production of 300,000 units is considered.

Rudolf Limpert

Publ: University of Utah

1977; 31p 10refs

Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977. Based on work subcontracted from MINICARS, Inc.

Availability: Reference copy only

HS-021 536

**STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?**

Various types of static, passive passenger restraint systems currently in use or in the design stage in automobiles include the following: use of a knee bar instead of a lap belt; seat design which limits forward and downward excursion of the buttocks and pelvis; the Peugeot rear seat shelf which serves as a substitute for a lap belt; windshields which are highly resistant to penetration by the head; energy-absorbing dashboards; and the General Motors energy-absorbing steering wheel column. The design and development of a passive, static restraint system not requiring air bags or belts appears feasible. The use of a knee bar and the seat cushion for principal energy input, of an extended dashboard for restraint of the upper thigh, of the dashboard for impact protection of the chest and shoulders, and widened, more sloping windshield for head impacts and restraint are within the current state of the art. Such a system promises to be more reliable, particularly as the car ages, and less costly initially. However, to efficiently design such a system, additional knowledge of the kinematics and injury tolerances of the human body is essential.

by John D. States

Rochester General Hospital; University of Rochester, School of Medicine and Dentistry

1977; 9p 30refs

Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.

Availability: Reference copy only

HS-021 537

**A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION**

A concept for diagnostic evaluation of motor vehicles is based on anticipatory maintenance, use of a microprocessor-based, strap-on instrumentation system, and a bootstrap implementation scheme wherein a first generation instrumentation system and operational plan is used to generate the data base upon which subsequent generations will be derived. Anticipatory maintenance involves trend testing, or detection of certain parameters of equipment condition based on their generic shapes for their patterns of decay. It is premised that overall performance provides clues to the condition of components. The strap-on instrument will measure the necessary attributes and compute the power and brake performance during operation of the vehicle on the road throughout its dynamic range. The electronics for the microcomputer are essentially in hand. Test command, historical data, cooperative hookup, calibration, and programmed analysis and readout are considered. As

**HS-021 538**

a result of recent progress in automotive control systems and onboard diagnostic data acquisition systems, a competent first generation instrumentation system/computer can be designed. The cost in limited production would be a few thousand dollars. Comparison of the cost of scheduled maintenance vs. periodic inspection plus maintenance as required shows that owner costs are lower for the former.

by Richard G. Salter  
Rand Corp.  
1977; 13p

Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

**HS-021 538****OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES**

Projections of the 1990 truck fleet include number of commercial trucks, truck miles, gallons of fuel used, average miles per gallon, total ton-miles, and ton-miles per gallon. There is a continuing trend of motor carriers to move away from Class III-V vehicles toward either lighter or heavier vehicles. Specific goals, with recommendations on how to meet them, are given for fuel economy, gaseous emissions, noise, safety, and operating constraints. The commercial vehicle of 1990 can be far more fuel efficient, quieter, and emit far less gaseous pollutants and can maintain the excellent safety record of the mid 1970's even if substantial increases in size and weight are ultimately adopted. Government regulations must be for the vehicle as a whole; trade-offs will be necessary.

by Henry E. Seiff  
Department of Transportation, Voluntary Truck and Bus Fuel Economy Prog.  
1977; 21p

Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

**HS-021 539****DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980**

Trends in regulation and in industry which influence the design of diesel engines include more stringent standards of smoke and gaseous emissions and of noise, as well as a demand for engines of increased horsepower. The possible ways to change horsepower of a diesel engine are to increase engine speed, displacement, or mean effective cylinder pressure level. Recent improvements in turbocharged engines, turbocharged aftercooled engines, and low compression ratio engines are described, as are potential designs of turbocompound engines and adiabatic turbocompound engines. Advanced component technology is discussed for fuel injectors, fuel pumps, variable timing, exhaust gas recirculation, advanced turbocharger, and engine braking. The heavy duty diesel engines of the late 1980's will not look much different from those of today. Current In-Line 6 and V-8 configurations will continue to be used almost exclusively, and there will be a definite increase in average horsepower to allow drivers to flow better with traffic, especially going up hills. Any horsepower increase will be made by increasing the engine mean effective pressure level.

**HSL 78-02**

The trend to higher horsepower has the potential to improve rather than reduce fuel mileage.

by A. J. Vander Bok; C. T. J. Ahlers  
Cummins Engine Co., Inc.  
1977; 16p

Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.

Availability: Reference copy only

**HS-021 540****FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.**

A survey of members showed a desire for a 112 inch wheelbase, four-door sedan weighing 3000 lb and having a six-cylinder engine, front wheel drive, high roof, a four passenger seating capacity, a large square trunk, many improved safety features, and better gasoline mileage. The following rates of dissatisfaction were noted: 80% with present fuel economy levels, 50% with shock absorbers, and 64% with rust protection on rocker panels, doors and fender skirts. The most wanted options were 40,000 mile tires, extended life brake pads and linings, high energy ignition systems, lifetime shock absorbers, heavy duty suspension systems, antiskid braking devices, five year rustproofing, and speed control. The most desired safety improvements were improved braking capability and improved headlight illumination. Other safety features desired included the following, in order of interest: glass protection, improved belt restraint system, high-visibility taillights, location of the headlight dimmer switch, fixed headrests, energy-absorbing bumpers, combination taillights, automatic headlight dimmers, and air bags or other passive restraint systems. Sketches of a suggested vehicle are presented.

by Robert J. Berke, comp.  
National Assoc. of Fleet Administrators, Inc.  
1977; 8p

Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

**HS-021 541****CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S**

The relationship is explored between vehicle design defect litigation and administrative processes for setting Federal motor vehicle standards and remedying defects under the National Traffic and Motor Vehicle Safety Act. The questions considered are whether or not there is a continued role for the courts, what the courts say, the frequency of lawsuits, the meaning of defect in the law of civil liability and in the Act, whether or not the courts are adequate to the task, what other factors bear upon liability for unsafe design decisions, and what the prognosis is for the 1980's. Prior to 1966, only the courts policed the industry's design decisions, and then only infrequently; the courts have not retired from this field. New

february 28, 1978

HS-021 544

theories of liability have been adopted and the frequency of suits has advanced. Although manufacturers must necessarily concern themselves with the most liberal expression of liability, the Act itself incorporates the "unreasonably dangerous defect" germ of civil liability and applies it more expansively. Accordingly, courts will place no greater burden on industry than has Congress. Distrust of the courts to make fair design decisions appears to have been unfounded; far-fetched cases are in fact rejected. Moreover, proliferation of no-fault laws and failure of behavior-oriented safety measures independently create additional pressures to hold manufacturers civilly liable when injuries occur. Accordingly, present trends foretell even greater involvement of the courts in design defect litigation in the 1980's.

by Joseph W. Little  
University of Florida, College of Law  
1977; 24p refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 542

#### VEHICLE RETARDERS: PRESENT AND FUTURE

The vehicle retarder, an auxiliary braking device which absorbs enough energy to reduce the need to use the primary brakes on long, downhill grades, is a practical alternative to equipping every truck and bus with nonfading brakes or to going down hills at extremely low gears and slow speeds. The engine brake, exhaust brake, and hydraulic retarder are vehicle retarders which work in relation to engine speed. Retarders related to driveline speed include electric retarders, hydraulic retarders, and wet friction retarders. Current technology of the various retarders is examined. The current retarding capability of 220 hp at engine speeds of 2000 rpm or driveline speeds of 1000 rpm is adequate for today's needs. Possible changes in retarding requirements include increased gross vehicle weights, a drop in the natural retarding of vehicles, and a trend toward increased downhill speeds. Vehicle retarder requirements may well double. These requirements will have to be met by increasing engine size to provide the necessary power, raising allowable engine speeds for retarding by 10%-20%, and improving retarder efficiency by 20%-25%. Such changes would increase retarder capability to about 380 hp.

by F. W. Mohney; G. M. Bloom  
Jacobs Mfg. Co., Bloomfield, Conn.  
1977; 12p  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 543

#### A TRANSIT OPERATOR VIEWS TRANSBUS

The history of the development of Transbus is given, and the transit industry's objections to the vehicle are listed. The Transbus Federal development program, part of the Bus Technology Prog. begun by the Dept. of Transportation in Dec 1970, suffered from a constantly changing set of criteria. Each successor to top administrative posts altered some aspect of the program's guidelines laid down by predecessors. Ultimately, after nearly a decade of changes, the Transbus was mandated on 19 May 1977. The program had served to kill the research and development activities in transit buses by private

manufacturers. The primary objection to the vehicle is its mandated 22 inch floor height, which is directly responsible for a series of design compromises which make the Transbus expensive to purchase, operate, and maintain. The low floor also requires use of new and unproven mechanical components in the bus, thus casting doubts on the reliability of the vehicle. Transbus had reduced operating capability, a higher purchase price, higher operating costs, and reduced seating. While the Transbus does represent an improvement in transit service accessibility for the handicapped in wheelchairs, it does so at an exceptionally high cost. Testing was inadequate. The project was product oriented rather than technology oriented. Transbus is an unwanted vehicle. Its use will be a financial burden both to the industry itself and, ultimately, to the U.S. taxpayer.

by Charles Whitten  
Toledo Area Regional Transit Authority, Ohio  
1977; 17p  
Presented at 5th International Congress and Automotive  
Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 544

#### TOYOTA'S LIGHT-WEIGHT NO-DAMAGE ELASTOMER BUMPER

Two recently developed bumper systems are described and compared. An energy-absorbing steel bumper system has been developed which has shock isolators of a silicone elastomer. It has been adapted to the Toyota Corona, Corolla, and Celica. The shock isolator has substantially low temperature sensitivity, easily adjustable maximum load, good energy-absorbing ability with the load-deflection curve indicating a pattern similar to a rectangle, and a total weight of about 40 kg per car. The necessarily thicker steel plate, however, makes the bumper somewhat heavier in comparison with other steel bumpers and makes it more difficult to comply with Part 581. An alternative to the steel bumper system with silicone elastomer shock isolators is a foam type bumper system composed of a rubber and polyurethane skin and a semirigid rubber and polyurethane foam core. Both a buckling type and a compression type were considered; the compression type was chosen. The compression type has an advantageously lower temperature sensitivity and a predictable load-deflection curve. It is also more processable and workable, and gives a smooth surface appearance. While production costs are about the same for the two types of foam, the compression type is more easily adaptable to motor vehicles of various weights. Skin molding is done by the so-called RIM-PU process and the Bayflex 101 system. The chief disadvantage of the foam type bumper is that it cannot be adapted to withstand collision speeds greater than currently required. A marketing concern is that the rubber and polyurethane bumper cannot take the metallic glossy surface the consumer is accustomed to seeing. A costing system is needed which will improve color matching to body paint and reduce hydrocarbon pollution.

by Takao Nomura  
Toyota Motor Co., Ltd., Material Res. and Process Devel.  
Dept. (Japan)  
1977; 27p 6refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 545

HSL 78-02

HS-021 545

#### THE TARGET CAR PROGRAM FOR 1977

The description of an ideal vehicle called the Target Car is used as a standard by which 41 cars of the 1977 model year are rated. The Target Car is described as capable of carrying four passengers; its characteristics include fuel economy, large interior size but small exterior size, passing and acceleration ability, low interior noise, crashworthiness, luggage and parcel capacity, handling, ride quality, ease of entry and exit, and maneuverability. Physical measurements, slalom tests, and subjective responses were used to test the cars. Tabulated results are presented. The top ten cars, in order of test scores, are the following: Datsun 810; Volvo 244 DL; Oldsmobile Delta 88; Mercedes Benz 3000; Volkswagen Dasher; Peugeot Diesel 504; Audi100LS; BMW 530iA; Pontiac Bonneville (403); and Chevrolet Caprice (305). Comparison with 1975 and 1976 models shows that domestic manufacturers are tending to design cars closer to the Target Car ideal. Tables of cost data are presented separately since cost was not a factor in the rating of the cars.

by John W. McDonald; Louis J. Bintz  
Automobile Club of Southern California; Engineering and  
Technical Service Div.

1977; 30p  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 546

#### THE IMPORTANCE OF AUTOMOTIVE FUEL ECONOMY STANDARDS

A brief review of the National Hwy. Traffic Safety Administration's (NHTSA) Automotive Fuel Economy Program is presented with its relationship to President Carter's energy program. The Office of Automotive Fuel Economy at NHTSA, in establishing maximum feasible fuel economy standards, must consider the technical feasibility of the standard, its practicality from an economic viewpoint, its consistency with other Federal automotive standards, as well as whether it is set at the appropriate level for national energy conservation and, for passenger automobiles, at a level to assure steady progress to the 1985 average fuel economy goal (presently 27.5 mpg). Three major national goals, to be achieved before 1985, are reduction of the demand growth in all sectors of energy use to less than 2%, reduction of oil imports to less than 6,000,000 barrels per day, and a 10% reduction in gasoline consumption from present rate. The four elements in the President's Energy Program relating to conservation which will have the most direct impact on automotive fuel economy standards are: gas guzzler tax and rebate, auto efficiency standards (beyond 1985), standby gasoline tax, and efficiency standards for light-duty trucks. Dockets have been established at NHTSA for all automotive fuel economy rulemaking actions, with files available for public review. Rulemaking for seven fuel economy standards has been initiated. Fuel economy regulations proposed by NHTSA are subject to review by the Office of the Secretary of Transportation and to interagency review; the closest involvement is with the Environmental Protection Agency. The pattern for fuel economy rulemaking is similar to that used by NHTSA in issuing Federal Motor Vehicle Safety Standards, with the modification of a greatly reduced time span in taking action. Interested parties still have the opportunity to participate, review, and comment. The

major steps associated with publication of a typical rule on automotive fuel economy are shown.

by Anees A. Adil  
National Hwy. Traffic Safety Administration  
1977; 23p

Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 547

#### TODAY'S THOUGHTS ON TOMORROW'S TRUCKS

Stringent regulations recently levied on the trucking industry with reference to air pollution control, safety, and noise limitation are cited, and the cost to the consumer is analyzed. Truck engine manufacturers must try to provide trucks with the fuel-efficient engines needed to keep costs down and to conserve dwindling natural resources of fuel, while at the same time having to meet the ever tougher air quality standards which work to offset any efficiency gains. The Operating Ratio, a standard used to evaluate a carrier's financial position, averaged 94.9 in 1976; the profit from the average trucking operation was 5% over expense before income taxes and interest on debt. Some of the governmental environmental and safety regulations have generated additions to operating expense in the order of 1% or 2% of operating revenue or 20% to 40% of the profit. Consideration should be given to the suggestions in the "Interagency Study of Post 1980 Goals for Commercial Vehicles" for improving the efficiency of truck transportation by adoption of existing technology, including increase in size and capacity, as well as by making changes in the restrictive state motor vehicle laws to help offset these costs. The general public, the regulatory agencies, and the state and Federal legislatures should understand that if social goals are not to be self-defeating there needs to be an evaluation of the trade-offs between the benefits derived and their rising costs.

by Lewis C. Kibbee  
American Trucking Assoc., Inc.  
1977; 21p 5refs

Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 548

#### COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS

Recent efforts to improve fuel economy while complying with stringent emission constraints have four main objectives: functional quality, installation suitability, raw material conservation, and environmental protection. A comparison between diesel and spark-ignition engine cost shows that the necessarily higher diesel engine production cost will be compensated for by its lower operating cost and longer service life. With modern high-speed swirl chamber diesel engines (especially when turbocharged) it is possible to attain power-to-weight and power-to-volume ratios similar to those of present gasoline engines. These engines feature good fuel economy and will meet emission level standards of hydrocarbon/carbon monoxide/nitrogen oxides (HC/CO/NOx): 0.41/3.4/1.5. Various vehicles and diesel engines were tested and compared. In order to

february 28, 1978

HS-021 550

meet the emission level requirement, exhaust gas recirculation was necessary, with the adverse results of increased smoke and odor, reduced durability, increased maintenance requirements and poor driveability. Driveability was tested with reference to the number of cold starts, idling quality, noise, surge, hesitation, pick-up performance, and acceleration jolt. The compatibility of diesel engines and lightweight vehicle structures of current and advanced crashworthiness was evaluated. Baseline vehicles were a VW Rabbit, VW Dasher, and Audi 100. The data obtained on the different diesel engines show that the more advanced diesel engine (turbocharged as compared to the naturally aspirated engine) offers definite engine advantages in terms of performance (efficiency, emissions, and noise) and vehicle packing, i.e. the lower volume requirements for the engine allow for greater flexibility for passenger comfort and safety at constant fuel economy and power. To demonstrate the compatibility of lightweight diesel power plants and vehicles of advanced safety features, high performance, acceptable emissions, and good fuel economy, an Integrated Research Vehicle (IRVW) was designed and built, powered by a turbocharged version of the Rabbit diesel engine and equipped with a five-speed manual transmission instead of the traditional four-speed box. General specifications and cutaway views of the IRVW are given; the passive restraint system is depicted. Crash test performances are presented. The data incorporated in this research vehicle show that it is feasible to build a safe automobile combining excellent fuel economy with eminent performance. However, further research will be required to arrive at a production vehicle. The reliability of the preloaded restraint system requires further extensive testing. Consideration should be given also to the narrow gap in regard to compliance with the HC and NO<sub>x</sub> emission standards because this compliance poses problems to the diesel engine unless an engineering breakthrough is found so that the NO<sub>x</sub> level of less than 1.5 gram per mile is maintained.

by B. Wiedemann; R. Schmidt  
Volkswagenwerk Res. Div.  
1977; 32p

Prepared for presentation at 5th International Congress on  
Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 549

#### OVERVIEW OF THE REPORT OF THE FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980

To set motor vehicle fuel economy goals beyond 1980 a joint Federal Task Force made a study of potential motor vehicle improvements and the overall environmental safety and economic implications of the paths toward achievement of the various national goals. In estimating and evaluating the potential motor vehicle improvements, the Task Force selected a broad range of design concepts, simulated the phase-in of these design concepts through production and into the market, and estimated the resulting effects on total fuel use, deaths and injuries, air quality and health, national resource availability, automotive industry, consumer costs, and national economy. Of 864 possible combinations of design elements, the study reported on ten that represent the spectrum from the 1975 average to an innovative structure with a diesel or an advanced engine and upgraded drivetrain. A number of design concept phase-in scenarios were also examined to ascertain the in-service fleet fuel economy level and thus the total fuel

savings potential. It was possible to represent just which of the numerous, simultaneously changing design elements produced the major cumulative fuel savings. The air quality analysis, performed chiefly by the Environmental Protection Agency, showed that substantial improvements in air quality have resulted from the automobile emission standards imposed to date; prospects for further reduction are good, partly because of the continued scrapping of older polluting cars and replacement with cleaner cars. Projections are made for concentrations of hydrocarbons, carbon monoxide, and oxides of nitrogen by the year 2000, with a health effects analysis, both assuming the implementation of a nationwide inspection/maintenance program, not now in effect. Estimates varied among the agencies on the Task Force as to the probability and extent of fuel economy losses, but there was agreement that whatever losses might occur with vehicles when first marketed under tighter emission standards would diminish in subsequent years of that same standard. A large increase in fatalities and serious injuries is predicted if new safety countermeasures are not adopted. To achieve fuel economies in the range of 26.0 to 27.5 mpg, a manufacturer would need to institute one or more of the following steps: reduce automobile acceleration below current norms, risking consumer rejection; provide incentives for smaller cars; adopt the lightweight diesel in appreciable numbers; accelerate the development of upgraded transmissions; introduce innovative automobile structures in the early 1980's (a difficult change-over schedule). Clearly the Study and the comments received on it have been influential in the decisionmaking associated with the 1981 through 1984 fuel economy standards, the Clean Air Act amendments, and the review of the passive restraint decision.

by W. H. Close  
Department of Transportation, Motor Vehicle Goals Task  
Force  
1977; 21p  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 550

#### ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE

A study of present and future energy consumption for urban transportation in the San Diego, Calif., area was made by developing scenarios portraying various alternative transportation modes, urban growth patterns, and population lifestyles for the next 20 years. Regions of the area considered were the downtown, central business district, the older suburbs, and the outlying, rapidly growing suburbs. The scenario of continued automobile use had the options of everybody wanting a full size luxury car and of the response to fuel price increases. The scenario in which mass transit is introduced had the options of public transit diversion, restricted automobile use, technological modifications of the automobile, and combined interventions. The scenario of changes in lifestyle had the options of the desire to live near work, the urban community cluster, and the total energy consciousness scenario. The most significant finding is that dramatic reductions in energy consumption are accomplished through the shifts in travel patterns resulting from reorientation of people's lifestyles. Implementation of automobile controls, power plant alternatives, and transit technology had far less potential for energy reductions than changing lifestyles. There should be reorientation of the urban

HS-021 551

spatial structure and concomitant shifts in travel patterns as well as wholesale rethinking of the basic form of personalized urban transport. A firm commitment to progressive, safe, energy conservative, and innovative forms of individual transportation is essential.

by Harvey E. Heiges  
Joint Center for Transportation Studies; San Diego State Univ.  
1977; 25p  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 551

#### **THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY)**

The ethical car must not waste metals or other materials, must not waste fuels, must not go too fast, and must not pollute the environment. It would weigh about 2000 lbs, have a four-cylinder engine delivering 40 mpg, would not exceed 60 mph, and would carry up to six passengers. The new Federal energy policy of high prices for and conservation of fuel is the opposite of the policy on which the Nation's transportation system was built. Trends in other areas of transportation include deliberate shrinking of railroads; airlines looking for multimodal ownership; buslines wanting intercity passenger business; trucks increasing in size and wanting multimodal ownership; and regional transportation systems increasing in importance. Other trends include the possibility of oil being valued by BTU's per barrel and miles per barrel rather than dollars of chemicals per barrel; increased use of diesel engines and broad-range distillate fuels; and lowered speed limits. Much of the inflation may rather be repricing of fuels and raw materials in the world marketplace; such new prices may be irreversible. Conservation seems to be a permanent national trend. Research in highway safety should concentrate on determining the limits of the human body in trauma, rearrangement of passenger seating, and providing bigger exits on van type vehicles. The income from a three-cent tax on gasoline could serve as a bounty on old cars and trucks, to encourage their replacement by more recent, and thus safer and less polluting, models.

by Gil Carmichael  
National Motor Vehicle Safety Advisory Council; National  
Transportation Policy Study Commission  
1977; 9p  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 552

#### **EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE**

Renault's Basic Research Vehicle (BRV) and Renault's production 20 TL are compared in terms of general specifications, collision performance, estimated statistical performance, and cost. The vehicles are similar in mechanical layout and equipment, although the BRV is considerably heavier and has less interior space. The Renault 20 TL affords protection for the belted occupants at impact speeds of up to 50 to 60 km/hr. The BRV, for a price increase of 25% to 30%, a weight increase of 11%, and a loss of interior occupant space of about 10%, gives protection to belted occupants at speeds of

HSL 78-02

between 60 and 70 km/hr in frontal collisions, and 50 to 60 km/hr in side collisions. The cost benefit ratio is a 12% decrease in fatalities. The greatly increased side protection of the BRV is responsible for the increase in costs. As side collisions concern only 30% of all fatalities in vehicles, the considerable gains in those saved do not represent a significant decrease in the overall number of people killed in vehicles. A balance in severity of frontal collisions could be found in a vehicle between the Renault 20 TL and the BRV by improving performance of the restraint systems in a structure identical to that of the Renault 20 TL. The economic advantage of the BRV's increased side protection has not been proved.

by Philippe Ventre  
Regie Nationale des Usines Renault (France)  
1977; 21p 8refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 553

#### **THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES**

The professional driver of the commercial vehicle seeks changes in design and operation of the truck cab, given that the vehicle is the driver's workplace. Interior noise levels should not be higher than 84 dB(A) for a ten hour shift, with a 3 dB(A) increase when exposure time is halved or a 3 dB(A) decrease when exposure time is doubled. Airtight cab design and better exhaust systems should eliminate or reduce such cab air contaminants as carbon monoxide, oil vapor, oxides of nitrogen, unburned hydrocarbons, aldehydes, phenols, and carbon particles as well as diesel fumes. Vibration and jostling need to be reduced. It is feared that the use of lighter construction materials to improve fuel economy may decrease the crashworthiness of the vehicle. Interior cab dimensions have been decreasing rather than increasing; sleeper berth dimensions should be increased. On-board diagnostic equipment is recommended to detect such malfunctions as tire pressure loss prior to failure. There should be improvements in steps, handholds, and walking surfaces behind the cab to reduce driver injuries during ingress and egress and while connecting air hoses and lights between cab and trailer. Fuel tanks should not be made of nonmetallic materials, and there should be regulations regarding the placement of fuel tanks. Motor carriers should, when changing from bias ply to radial ply tires, follow the recommended practice of changing the vehicle's tires in given stages. There should be more coordination and cooperation among such Federal agencies as the National Hwy. Traffic Safety Administration, the Bureau of Motor Carrier Safety, and the Occupational Safety and Health Administration. A length limitation should be established on the cargo-carrying portion of the vehicle. Allowable tandem axle weights should be increased to 35,000 lbs. The allowable gross vehicle weight should be maintained at 80,000 lbs. Effective maintenance programs should be implemented by motor carriers. Design may

february 28, 1978

HS-021 556

be as important to driver fatigue levels as the number of hours driven.

by R. V. Durham  
International Brotherhood of Teamsters, Safety and Health Dept.  
1977; 14p 16refs  
Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 554

**THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS**

Flexible foams are recommended for both interior and exterior vehicle use as absorbers of kinetic energy of collisions. Both static and impact tests were conducted to find foams having the following characteristics: stability at high and low temperatures; impact shatter resistance; CLD impact stress-strain curve targets; increase of specific energy absorption in penetrating impacts, with structural skins; negligible rebound; maximum compression rate sensitivity of 1% of increased compression resistance for each additional 1 mph; maximum recovery; meeting environmental standards; competitive cost in mass production; and recyclability. Technology is not the problem: suitable foams exist for use both as bumpers and as interior cushioning. The small car in particular needs to incorporate all possible protective systems in order to reduce the inequities being imposed on its occupants in a collision situation.

by Addison S. Beckley; Lester V. Ottinger  
Automobile Safety Corp.  
1977; 13p 27refs  
Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 555

**VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA**

The goal of a multimillion dollar motor vehicle diagnostic inspection (MVDI) demonstration program was to determine if a national system of diagnostic inspection centers would be cost effective in that public benefits would exceed program costs. A treatment group of 1968-1973 model year cars was matched with a control group. Data gathered included pass/fail and diagnostic information as well as repair and maintenance costs for inspection-related items and for normal maintenance between inspections. Stations of the computerized inspection lane contained the following: roller brake tester, chassis dynamometer, exhaust emissions tester, scuff gauge, front-end alignment tester, and platform brake tester. The software system is described. Analysis of the program's impact on safety and emissions shows that the program can result in safer vehicles, reduced pollution, improved fuel economy, generally lower repair and maintenance costs, and/or improved repair quality. Condition of the vehicles significantly improved over the 15 months of the program. A savings of 5.7% was reported on tune-ups and carburetor work and a 4.7% improve-

ment was reported in fuel economy. Of the 93% of participants who said they would join such a group again, over 60% said they would be willing to pay \$10 or more.

by Joseph J. Innes  
National Hwy. Traffic Safety Administration  
1977; 26p 6refs  
Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 556

**INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS**

A commentary on the Interagency Study of Post-1980 Goals for Commercial Motor Vehicles points to specific deficiencies in the Interagency report and proposes a more appropriate methodology for establishing future goals, commenting that the Task Group failed when establishing goals for safety, emissions, and noise to assign priority to fuel economy. A substantial increase in the size and weight capacity of commercial vehicles is recommended to improve fuel economy. The Motor Vehicle Manufacturers Assoc. endorses the Task Group recommendation to continue the joint industry/government voluntary approach to energy conservation for commercial vehicles. The stringent goals proposed for elimination of noise, emissions, and accidents must be tempered by reality; proposed countermeasures should not disrupt the basic mobility and service functions performed by commercial vehicles. The Task Group recommendation for a 75 dB(A) noise standard in the mid-1980's is not technologically feasible for a full range of products; the governmental noise research is completely inadequate. Further research should be carried out in the area of safety, the cause and effect relationship of accidents involving commercial vehicles; in the area of noise, evaluating health effects, annoyance factors, and the types and mix of sources of noise in the community; and in the area of emissions, assessing properly the health effects of oxidant, oxides of nitrogen, and certain unregulated pollutants. Better methods of estimating the effects of atmospheric reactions and dispersion are required in order to determine long-range goals which are based on factual information. Recommendations also include the full evaluation of the trade-offs and risks associated with potential countermeasures, both qualitatively and quantitatively; establishment of priorities for all types of goals; and determining the economic consequences of meeting multiple goals on the manufacturers, users, shippers, and the public. MVMA specifically proposes: a limited scale but representative field test of vehicles meeting proposed government regulations to identify problems before widespread implementation of new technology is required; the voluntary approach to fuel conservation through dissemination of information on fuel economy measures which coincidentally can improve profitability, and adoption by states of uniform size and weight limitations in accordance with current Federal guidelines; a more flexible approach to the evaluation and reduction of the risk of accidents; and establishment of a joint government, industry, public advisory council to cover the

HS-021 557

several issues and needs of society relative to commercial vehicles.

by Peter Griskivich  
Motor Vehicle Manufacturers Assoc. of The United States,  
Inc., Motor Truck Manufacturers Div.  
1977; 58p 11refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 557

#### **CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE**

The Mobile Proving Ground (MPG) program interviewed vehicle owners throughout the U.S. and parts of Canada to determine their evaluation of vehicle performance, and awareness of operating problems such as hard starting, misfire, hesitation, rough idle, detonation, and run-on. Responses are tabulated according to model year. Results of the surveys, and of similar surveys and interviews, indicate that there is a trend of increasing unhappiness with the new model vehicles. Owners of late model vehicles reported high incidences of hesitation, rough idle, run-on, and hard starting, but did not report an increasing number of tune-ups. Over 41% of 5666 U.S. and Canadian vehicles tested failed the New Jersey idle test emissions standards. Newer vehicles had significantly lower emissions. Vehicle performance, which is directly related to emissions, fuel economy, and safety, can deteriorate significantly before the owner becomes aware of it. As many as 75% of vehicles on the road may be in this condition. Serviceability should be designed to allow for the trend to maintenance performed by owners. Implementation of periodic vehicle inspection and maintenance programs should result in substantial improvement in air quality, safety, and fuel economy.

by Richard C. Teasel  
Champion Spark Plug Co., Res. and Devel.  
1977; 21p

Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 558

#### **THE BETTER THINGS IN LIFE ARE NOT FREE**

Analysis of the experience of the past ten years suggests some factors which would make the safety goals more reasonable and attainable, and would facilitate Federal rulemaking procedures. The automobile industry feels a conflict between Federal requirements concerning safety, emissions, and fuel economy on the one hand and the public demands for family needs, versatility, performance, and comfort at an affordable price, on the other hand. Industry and government should work together to reach such goals as reduced fatalities and injuries on the highway. Vehicle regulation may have reached the point of diminishing returns. The key regulatory decision currently faced by the Federal government is how to increase use of occupant restraints in automobiles. Legislators, the courts, and the insurance companies should help support such use of restraints. Rulemaking should be based on well developed and documented benefit-cost effectiveness determination. Research should be conducted on the technology that will meet the requirements of a standard. There should be adequate technical development and pilot evaluation of a

HSL 78-0

proposed safety feature prior to final rulemaking. The benefit of new rules should be examined in light of past performance such as via the national accident sampling system. There need to be sufficient time between similar rules in order to determine whether a progressive, favorable effect was obtained. There should be greater analysis of consumer reaction and response to regulation, and there should be programs to educate the consumer and gain cooperation.

by L. L. Baker  
Chrysler Corp.  
1977; 15p 4refs

Presented at 5th International Congress on Automotive Safety  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 559

#### **BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES**

Optimization methodology is applied to the problem of trade-offs among vehicle occupant safety, emissions, fuel economy, and cost. The procedure involves identification of input variables, goals, weighting factors, performance criteria, causal relationships among the input variables and output goals, external variables, and a technique for picking sets of inputs, evaluating the resultant outputs, and choosing optimum solutions. An example using published data indicates that the following set of actions would yield an optimum cost/benefit ratio: fuel economy in new cars of close to 20 mpg in 1980 and 28 mpg in 1985; mandatory lapbelt and shoulderbelt legislation in 1978 and thereafter; emission standards near 1977 levels through 1981 and then somewhat lower beyond 1982, with statutory standards delayed until 1990; and gasoline taxes with rebates. The independent actions of the past have not been successful in reaching society's goals of automobile safety and fuel conservation.

by R. Eugene Goodson  
Purdue Univ., Inst. for Interdisciplinary Engineering Studies,  
West Lafayette, Ind.  
1977; 22p 21refs

Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 560

#### **FIELD RELEVANT TESTS: OUR MOST IMPORTANT MOTOR VEHICLE GOAL**

In the achievement of reliable correlation between laboratory and real world benefits, quantitative trade-off studies for such factors as fuel economy and safety must involve specific, objective laboratory goals or health needs. Refining a safety goal means establishing the relation between a laboratory test goal and what that goal will bring in real accident benefits. The most important national motor vehicle goal is establishing field relevant tests by which to accurately measure benefits. If the cost of meeting one standard is reduced, the money saved may be helpfully invested in more field relevant tests. In the field of safety, good field relevant, injury mitigation tests should be developed. A test of human tolerance, involving a test dummy, requires one based on human response data. Suggested further research on air cushions including a comparison of field inju-

1  
february 28, 1978

HS-021 563

ries with laboratory measured injury criteria on air cushion and nonair cushion vehicles could show not only the potential merits of air cushions, but how these merits relate to relative laboratory dummy injury criteria for air cushion and unrestrained dummies. The cost of such a study should be set against the national cost of implementing a regulation that would mandate air cushions on all vehicles, estimated as at least a billion dollar annual national commitment. Even if there were no need for balancing fuel economy vs. vehicle safety vs. emission control vs. noise control, it would still be vital to consider field relevant tests as an urgent priority.

by David E. Martin  
General Motors Corp., Environmental Activities Staff  
1977; 8p 3refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 561

**ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC**

A review is given of basic concepts of human behavior, and of behavioral modification, that are relevant to acceptance of motor vehicle and highway safety programs. Past motor vehicle standards are examined in light of these concepts, with a description of possible methods for improving public acceptance of future changes in motor vehicle design and construction to promote safety. There should be a better understanding of the extent to which subtle impairments or combinations of impairments of people exist, the equally subtle way in which task demands may escalate, and the degree to which these two types of factors occurring simultaneously may add up unpredictably to a crash situation. Environmental contributions to task demand include: limited visual field or visual perception because of vehicle design or configuration, such as the trend towards larger trucks, smaller cars, and two-wheeled vehicles; problems with aerodynamic incompatibility; inadequacy of human factor engineering in vehicle design; and inadequacy of road design and maintenance. For the crash and post-crash phases, the technology already exists in prototype or production form for greater application of passive protection during the energy transfer phase, for reduced fire hazards and for greater ease in extricating people after a crash. Improvement of emergency medical services is continuing and is well accepted by the public and by health professionals. However the interaction of subtle and uncorrectable forms of human impairment have interfaced with subtle forms of increased task demand to produce losses of control that are not amenable to improvement through conventional legal or education methods. Maximum use has not been made of possible resources and stratagems, such as the successful health belief model used by health educators and applicable to the field of highway safety. The main obstacle to acceptance of motor vehicle standards lies in the inability of the public to perceive the benefits of preventive action in the field of motor vehicle and environmental standards. This inability is in turn ascribable to the National Safety Council's bias in the direction of telling people that improvement will come only by changing themselves, and that the motor vehicle and other environmental standards and programs will have little effect. In addition to education of the public, a strong effort should be made to

professionalize the police officers, motor vehicle department, and highway personnel.

by Julian A. Waller  
University of Vermont  
1977; 15p 10refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 562

**ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION**

Prescribed standards for reducing damageability and increasing car safety are in apparent conflict with mandated goals for improving automotive fuel economy and lowering exhaust emissions. The conflict can be resolved by use of lightweight aluminum components; car size can be held to generous, lifesaving dimensions while decreasing fuel consumption and exhaust emissions by reducing vehicle weight. Initial costs are increased but lifetime purchase and operating costs are sharply reduced. Consumer desires for performance, passenger comfort and capacity, luggage space, and trailer towing capacity can be met by this means. The aluminum industry is developing stronger, more workable alloys that can be used within existing manufacturing systems to achieve weight savings up to 70% over steel, with a minimum cost penalty. The specific data presented cover fuel economy-vehicle weight relationships for 1977 automobiles, car size/weight/fatality relationships for serious accidents, weights and cost differences of specific components in aluminum and ferrous materials, and proposed automobile configurations for achieving fuel economy goals.

by C. N. Cochran; W. C. Weltman, Jr.  
Aluminum Co. of America  
1977; 28p 21refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 563

**AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS**

Trade-offs between vehicle design for safety and for reduced damageability are difficult to evaluate in part because there is a scarcity of real world data available. New statistical data are provided regarding auto crash damage experience of the 1972 through 1976 model year cars, based on two large scale programs for collection of information from damage repair estimates. The first project is an ongoing survey, begun in 1973, which involves the collection of information from repair estimates written during their first year of operation. The second program, begun in Jan 1976, involves the collection of information from repair estimates for all model years of cars. Distribution of accident impact points, auto repair costs, frequency and cost of replacement of specific parts, and the distribution of expenditures to various segments of the auto repair industry are presented. Comparisons are made between vehicle model years and vehicle market classes as well as between some selected car lines. The analyses described illustrate that differing automobile design characteristics result in varying

HS-021 564

patterns of crash damage. Evaluation of design changes in the future should include measures of actual crash experience in addition to controlled laboratory crash tests.

by James Casassa, 2nd.; Richard E. Gardner; Wayne Sorenson  
State Farm Mutual Automobile Insurance Co.  
1977; 30p 6refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 564

#### IMPROVEMENTS IN THE SAFETY OF URBAN TRANSIT COACHES

The Transbus program, sponsored by the Urban Mass Transportation Administration, is a research, development, and demonstration project to develop improved, safer buses. A description is given of the analyses, tests, and resulting specifications for safety features which have evolved from the project. The testing program included bumpers, seats, full vehicle crash, and interior, with other tests for performance, endurance, and revenue demonstration. New features in the Transbus design concepts are lower skirt clearance, improved right-side mirror, curb lighting, energy-absorbing bumpers, and smooth front and rear body surfaces, expected to reduce by 20% pedestrian fatalities associated with urban buses. Such features as padded seat backs, improved seat back assists, assist rails in the doors and overhead, impact barriers at the fare box, lower floor height and steps, and wider doors would also reduce passenger accidents. These features, plus the energy-absorbing bumpers and sidewalls may decrease traffic accident claims costs by as much as 35%. Such safety features could decrease operating costs by about one cent per mile, when compared to current buses, a 30% reduction in safety-related costs. Several, though not all, of the safety features are being incorporated into the RTS-II design of General Motors and into the 870 design of Rohr-Flxible. The results indicated that the safety features could account for a savings of as much as \$5,000 during the life of a typical transit bus.

by John F. Wing  
Booz, Allen and Hamilton Inc.  
1977; 30p 9refs  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 565

#### THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES

A review of available data indicates that the Federal motor vehicle control program is not reducing emissions from in-use cars as rapidly as expected. Improper adjustments and a lack of proper maintenance seem to be major reasons for the shortfall. The ability of short tests to identify high polluters is established; the service industry seems capable of repairing failed cars at reasonable cost. Costs of repairing catalyst cars are still somewhat of a question although initial indications are that required repairs will be similar to those on noncatalyst cars. Deterioration of vehicle emission levels following inspection maintenance is still subject to some dispute, but a best estimate indicates that inspection maintenance will slow down the long term rate of emission control degradation. Inspection

HSL 78-02

maintenance is an effective means of bringing cars into compliance with standards, and early results from New Jersey's and Oregon's inspection maintenance programs are encouraging.

by Michael P. Walsh  
Environmental Protection Agency, Technical Support Branch  
1977; 32p  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 566

#### ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT

The three nationally legislated goals of energy conservation, safety, and protection of the environment meet in conflict in the design and functional characteristics of motor vehicles. A plan is offered by which the effects of proposed regulations or laws which create motor vehicle characteristics can be visualized or analyzed in relation to the large numbers of interest groups potentially affected. In this analysis, justice and equitableness are given narrow definitions based on their role in past policy compromises. Their appearance to groups is located in terms of beneficial and costly effects upon groups of a given set of motor vehicle characteristics. The situation of each identified group is studied individually for "justice" factors, while "equitableness" in receiving benefits and bearing costs is studied according to selected pairs of groups. Tabulations reveal the need for better loss data, a subject familiar to safety workers. However, the inequities and possible adjustments can also be studied in terms of group opinion which may be more important in the political outcome. The tabulations systematically reveal opportunities to construct a political majority for a set of characteristics. The method helps to identify inequities and waste due to imprecise application of regulations and suggests corrections not located by cost/benefit analysis. Appended are lists of factors for analysis of "justice" obtainable by groups and of general loss factors in equitableness analysis; unachieved fuel economy factors - equitableness analysis; health loss through emissions - equitableness analysis; motor vehicle characteristics to be analyzed; interest groups potentially affected by change in energy conservation, safety, and emissions characteristic of vehicles; apparent "justice" situations for sample interest groups; and a list of general methods of correcting inequities.

by Henry H. Wakeland  
National Transportation Safety Board, Bureau of Plans and Programs  
1977; 27p  
Presented at 5th International Congress on Automotive Safety,  
Cambridge, Mass., 11-14 Jul 1977.  
Availability: Reference copy only

HS-021 567

#### EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS

Three in-hospital educational programs for postpartum women, designed to increase the use of crash protection devices for infants in cars, were evaluated in comparison to a group that

february 28, 1978

HS-021 570

received no education. The programs consisted of: literature, plus making infant carriers readily accessible and convenient to purchase; literature, plus a personal discussion, plus making infant carriers readily accessible and convenient to purchase; and literature, plus the offer of a free infant carrier. The programs increased the extent to which infant carriers were used to transport babies in cars, but had little or no effect on the key outcome measure: use of infant carriers fastened by the car seat belt so that crash protection is provided. Rates of such use were low in all groups, not exceeding three in ten. It is concluded that ways of providing increased crash protection to infant and child travelers in addition to use of restraint systems requiring the active, voluntary cooperation of parents must be encouraged. Pediatricians should routinely inform parents of the importance of transporting their infants and children in appropriate restraint devices. "Passive" (automatic) protection techniques, such as air bags and vehicle interior modifications, have great potential in this regard.

by Keith S. Reisinger; Allan F. Williams  
University of Pittsburgh, Dept. of Pediatrics and Community  
Medicine; Children's Hospital of Pittsburgh, Pa.; Insurance  
Inst. for Hwy. Safety, Washington, D.C.  
1977; 28p 33refs

Availability: Infant Restraints, Insurance Inst. for Hwy.  
Safety, Watergate 600, Suite 300, Washington, D.C. 20037

HS-021 568

**AMERICAN ASSOCIATION FOR AUTOMOTIVE  
MEDICINE. PROCEEDINGS OF THE 21ST  
CONFERENCE, VANCOUVER, BRITISH COLUMBIA  
[CANADA], SEPTEMBER 15-17, 1977**

Thirty-six papers are presented on such aspects of automotive medicine as motorcycle legislation, emergency medical services, the physical and emotional problems of drivers, vehicle structure and restraints, and accidents involving children. Other topics considered include the trucking industry and its drivers, schoolbus crashes, fatal accidents involving alcohol and/or drugs such as barbiturates or valium, screening for impaired drivers, and rehabilitation of drivers convicted of driving while intoxicated. Papers dealing with injuries consider arthritis from knee contact with dashboard and bumper, spinal cord injuries, and injuries characteristic of motorcycles of various kinds. Other papers concern investigation of the roadway environment, the role of the medical examiner, the coroner's system in Ontario, Canada, trilevel accident studies, the National Accident Sampling System, and incompatible standards of highway safety.

by Donald F. Huelke, ed.  
American Assoc. for Automotive Medicine, P.O. Box 222,  
Morton Grove, Ill. 60053  
1977; 440p refs  
Availability: Corporate author

HS-021 569

**IMPACT OF MOTORCYCLE HELMET LAW REPEAL**

The incidence of head injuries of motorcycle operators and passengers was studied for three months before and three months after the repeal of the mandatory helmet usage law in Kansas. Helmet usage rates were also studied. Severity of head injuries was evaluated by the Abbreviated Injury Scale (AIS) and total severity of each individual accident was evalu-

ated by the Injury Severity Score (ISS). Helmet usage decreased from greater than 95% to less than 10% on urban streets and to less than 50% on major highways. The incidence of head trauma increased by 70% between 1975 and 1976. The incidence of head trauma was 81% greater for those not wearing a helmet at the time of accident than for those wearing a helmet. The severity of head injury was 56% greater for those suffering those injuries without benefit of helmets than for those who were wearing helmets at the time of injury. The crude death rate for those not wearing a helmet at the time of accident was 310% greater than the crude death rate for those wearing a helmet at the time of accident.

by Michael Lummis; Norman E. McSwain, Jr.  
University of Kansas Medical Center, Dept. of Emergency  
Medical Training, Kansas City, Kans.  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p1-13  
1977; 7refs

Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.

Availability: In HS-021 568

HS-021 570

**THE IMPACT OF A MOTORCYCLE LIGHTS-ON  
LAW**

The effect of a motorcycle lights-on law in North Carolina was examined by analyzing accident data by type of crash and by light condition for a six-year period (1972-1976). The law, effective 1 Sep 1973, requires that motorcycles have both head lamps and rear lamps on at all times while the motorcycle is in operation. The proportions of motorcycle crashes that were daylight and multivehicle were compared with daylight and multivehicle crashes of other types of vehicles. It was found that there was a significant drop in the proportion of daylight multivehicle crashes, leading to the conclusion that the law had its desired effect. Neither was there any evidence to support the contention by the American Motorcyclist Assoc. that the motorcycle lights-on law leads to an increase in daytime crashes in which the automobile hits the rear end of the motorcycle. The new data reporting form probably did not systematically influence the outcome of the analyses. Although the analyses do not entirely control for whatever effect on motorcycle driving patterns the energy crisis might have had, it is difficult to see how the energy crisis per se could have accounted for the findings. Tabulated data are presented.

by Patricia F. Waller; Lindsay I. Griffin, 3rd.  
University of North Carolina, Hwy. Safety Res. Center; Texas  
A and M Univ., Texas Transportation Inst.  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p1-13  
1977; 10refs

Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.

Availability: In HS-021 568

HS-021 572

HSL 78-02

HS-021 572

### DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]

The first priority of British Columbia's Emergency Health Services Commission, established 1 Jul 1974, was ambulance service. There are now 160 ambulance services with 270 ambulances and 432 full-time and 2000 part-time (on call) employees. Since no commercially available ambulance met the perceived needs, the Commission set up its own workshop and now builds ambulances at the rate of just over one per week, based on a one-ton chassis. These vehicles are of high quality, meet specifications exactly, and cost \$6000 less than a comparable commercial vehicle. All full-time personnel have received at least 400 hours of training; some have been further trained as paramedics. An air ambulance service has recently been established. Fees (by whatever route of transportation) are, for residents, \$15 for the first 25 miles and twenty cents per mile thereafter to a maximum of \$100 per call; the service is heavily subsidized by the Provincial Government. Other activities of the Commission include provision of a physician for the fishing fleet during the season, public education in first aid and basic life support, and provision of packaged instruction programs for emergency departments of community hospitals. Communications have been improved by the establishment of an emergency telephone number and by ambulance radios. The Commission is also responsible for the medical aspects of disaster planning.

by P. M. Ransford  
Ministry of Health, Emergency Health Services Commission,  
B.C., Canada  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p40-3  
1977  
Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 573

### A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA

A study was made of Saskatchewan (Canada) ambulance call reports and hospital emergency room and in-patient reports to identify the care pattern of the traumatized patient and the ability of the emergency medical system to handle the increasing number of motor vehicle accident victims. A method was developed to record the level of care that motor vehicle traumatized accident victims receive from the time of the accident through the definitive medical care stage. The study data readily pointed out the low level of emergency care received by the patients that arrived in the emergency department. The in-patient study showed that an acceptable level of care and rapid stabilization occurred and that the scope of injuries and conditions treated was comparable to similar geographical North American communities. The data gathering method could be used in any hospital or for any ambulance company. A three to six month period is required to record and study data on the level and type of patient care. Recommendations are made for the following: an emergency room data recording system for trauma cases in the study area (Saskatoon and re-

gion); an ambulance audit system; a management followup audit system to study the relationship of early treatment to morbidity; an improved radio communications system between ambulance and emergency room; a rationalization of emergency medical services in Saskatchewan; more training of ambulance personnel; and training of police in emergency evaluation and triage.

by R. L. Ailsby; F. G. Inglis  
University of Saskatchewan, Dept. of Surgery, Canada  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p44-55  
1977; 18refs  
Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 574

### A DEGREE PROGRAM FOR EMS ADMINISTRATORS - A UNIQUE APPROACH

The University of Kansas Medical Center offers a Bachelor of Science degree in Emergency Medical Services Administration which involves two and one half years at any accredited college or university in Kansas and the remaining one and one half years at the Medical Center. Prerequisites during the first part of training include 18 to 21 hours of general, liberal arts courses, 27 hours of business courses, and 18 hours of science courses. Courses taken at the Medical Center include the following: etymology, advanced physiology, emergency medical technician, communications and transportation systems, administration, electrocardiology, advanced care of sick and injured, clinical experience, defensive driving and extrication, and a field internship. Upon completion of the field internship, the student is able to sit for the state certification examination for emergency mobile intensive care technicians; it is assumed that the graduate will begin work in the field as a paramedic, then advance to an administrative level.

by Mary Beth Skelton; Norman E. McSwain, Jr.  
Kansas University Medical Center  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p56-63  
1977; 1ref  
Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 575

### DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY

The Ontario physician has a legal responsibility to report to the Registrar of Motor Vehicles any person of driving age who in his or her opinion is suffering from some condition which would make the person liable to operate a motor vehicle dangerously. Objections to the statute are that it damages the relationship between physician and patient and that the wording allows a subjective judgment which is difficult to deal with in the courts. A number of legal cases are considered in which the motor vehicle accident was clearly due to the driver's physical disability, in order to define the scope of the physician's duty. The cases deal with disorders of the mind, diabetes, and heart disease. It is a matter of degree in each

february 28, 1978

HS-021 577

case as to whether an individual with a chronic ailment should refrain from driving. Recent cases, however, combined with the intent behind such statutes as Section 143 of the Ontario Hwy. Traffic Act indicate an unsympathetic approach to a physician who places his patients' welfare ahead of that of society. Since the 1975 amendment of the Ontario Highway Traffic Act to require wearing of seat belts, individuals can seek a certificate of exemption from a physician. In case of legal action following an accident, however, the physician may be responsible for providing compensation for those injuries caused by failure to wear a restraint if it can be proved that the physician did not act reasonably and responsibly in issuing such a certificate.

by Gilbert S. Sharpe  
Ontario Ministry of Health; McMaster Univ., Faculty of Health Sciences (Canada)  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p64-85  
1977; 16refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 576

#### MEDICAL REPORTING OF DRIVERS WITH EMOTIONAL PROBLEMS

A review of the literature concerning emotionally disturbed drivers of motor vehicles shows that although the problem has been noted since 1906, there has not been any clearly defined statistical evidence of the frequency of accidents involving such drivers or any specific methodology developed for identifying such individuals prior to licensing. The problems of emotional illness have been particularly difficult to define when the physician has been asked to list diagnoses with little correlation of the condition to driving impairment. A reporting form used in Wisconsin for the past two years asks three questions: demonstration in the past three years of homicidal, suicidal, or assaultive behavior; dangerous use of a motor vehicle; and manifestation of significant side effects of medications at prescribed dosage that might affect driving ability. A three-month study of the method (Dec 1976-Feb 1977) reviewed recommendations for not licensing, those in which the individual was rated as poor in reliability in taking medication, and those for whom the physician marked "no opinion." There were sufficient inappropriate responses to suggest that an attempt should be made to emphasize the limited areas of concern. The questions concerning dangerous use of a motor vehicle and medicine side effects could be dropped. In Wisconsin the Center for Public Representation has made a strong case against the present method of handling driver licensing with regard to mental illness. A recent publication of the National Hwy. Traffic Safety Administration on a suggested medical report form for mental and emotional conditions is based in part on the Wisconsin form but asks additional questions, thus complicating rather than simplifying the matter. The Wisconsin approach to the licensing of the emo-

tionally ill is a step forward because it emphasizes certain types of overt behavior most likely to impair driving.

by James L. Weygandt  
State Medical Soc. of Wisconsin, Com. on Safe Transportation, Sheboygan Falls, Wis.  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p86-100  
1977; 26refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 577

#### A DECADE OF RESEARCH IN VEHICLE REAR LIGHTING: WHAT HAVE WE LEARNED?

Research and development since 1967 in rear lighting of vehicles have been concerned with intensity of signal lamps, functional separation and color coding, colors of marking and signaling lamps, flash rate of turn and hazard warning signals, coasting signals, accelerator position signal, deceleration/panic stop signal, deceleration rate signal, and stopped vehicle and speed signals. Recommended minimum and maximum intensities at night and the minimum in the day for presence, stop, and turn signal lamps of various systems are tabulated. The most effective lighting systems are those which have complete functional separation which requires six lamps as well as different colors for each of the functions. Suitable chromaticity coordinates have been defined to avoid confusion of reds and yellows with each other, and of green-blue with white. As for fog lights, very large increases in intensity are required to achieve modest increases in visibility, since the relationship between visibility and intensity is basically an exponential one. Flash rates of 2-3 Hz instead of 1-2 Hz improve effectiveness of turn and hazard warning signals. Information to be displayed by rear vehicle lighting has traditionally included presence, brake, turn, back-up, and hazard warning; in addition, other messages might be deceleration (coasting or panic stop), deceleration rate, acceleration, stopped vehicle, and speed. A potential rear lighting system consists of high mounted presence lamps (green-blue), mounted above the row of presence/speed-indicator lamps. Yellow turn signal lamps are mounted high on the rear deck and outboard, while red stop lamps are mounted low on the rear deck and outboard. A coasting signal is combined with the stop lamps. The speed display incorporates a red lamp in the lower center of the rear deck which is lighted whenever the speed is below 5 mph. Six green-blue presence/speed lamps have different patterns indicating speed range. Studies show that drivers can readily recognize the speed display.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p101-12  
1977; 26refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 578

### THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY

The effectiveness of side door reinforcement beams in reducing occupant injury from side impacts was evaluated to determine whether cars fitted with 5 mph energy-absorbing bumpers, involved as the striking vehicle in side impacts, significantly affect the injury severity of occupants in the struck vehicle, particularly from the point of view of degrading any benefit obtained from the side door beam. Data were obtained from 34,253 accidents which occurred Nov 1969-Apr 1975 in the eight-county area surrounding Buffalo, N.Y. Only accidents in which the struck vehicle suffered compartment damage were included. Injury severity is reduced to some extent in vehicles equipped with side door beams but the effect is small. For unrestrained occupants seated on the struck side, there was a significant side door beam benefit; for cars with side door beams, the proportion of no injuries was higher (65.1% vs. 60.4%) and the proportion of injuries of moderate or greater severity, lower (9.3% vs. 13.0%). The effect was not as noticeable for restrained occupants. For occupants seated on the opposite side to that struck, door beams do not provide any significant benefit irrespective of restraint use. In terms of occupant protection, restraints offer significantly more benefit than side door beams. Cars fitted with energy-absorbing bumpers present a less aggressive striking vehicle but the effect is small. Energy-absorbing bumpers do not appear to degrade the benefit obtained from side door beams.

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 Contract DOT-HS-053-3-609  
 Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p113-26  
 1977; 6refs  
 Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
 Availability: In HS-021 568

HS-021 579

### INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]

The injuries of 157 fully restrained (lap/torso belted) occupants involved in 125 collisions during 1 May 1976-30 Apr 1977 in the London, Ontario area are studied to determine collision forces and mechanisms of injury. Twelve occupants in nine collisions sustained serious, critical, or fatal injuries. A major factor in three of the cases was faulty seatbelt function. Vehicle rollover was a major factor in three other cases, as well as major intrusion into the occupant space in one of those cases. Significant intrusion into the occupant space (particularly from side impact) was common to all of the killed occupants and to three of the four critically injured occupants. There was only one case of ejection, due apparently to a faulty locking mechanism on the seat belt. There were 145 occupants in the injury range of none to severe; 85% of them were wearing properly functioning seat belts, and the other 15% were wearing seat belts that were not properly adjusted. Major impact of the vehicles involved was 40% frontal, 40% side, 15% rear-

end, and 5% rollover. Intrusion into occupant space occurred in only 20% of cases and was minor. Points of contact with the vehicle interior are listed along with the percentages of drivers and front passengers making such contact. Also tabulated are body regions of major injury by percentage of drivers and front passengers affected. The three-point restraint system effectively reduces severe injury and death.

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 Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p127-45  
 1977; 6refs

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977. Funded by Transport Canada, Rd. and Motor Vehicle Traffic Safety Branch.

Availability: In HS-021 568

HS-021 580

### PEDIATRIC ROAD ACCIDENTS

Of 195 children treated at the Vancouver Health Sciences Children's Centre, Winnipeg, Canada, for road accidents between 1 Jun 1975 and 31 Dec 1976, 35% were motor vehicle/pedestrian accidents, 24% were motor vehicle passenger accidents, 26% were bicycle accidents not involving motor vehicles, 8% were motor vehicle/bicycle accidents, and another 8% were motorcycle accidents. Motor vehicle/pedestrian accidents frequently resulted in severe injuries of which the fractured femur was the most common. Motor vehicle passenger accidents resulted in less severe injuries involving the skull, facial bones, and upper extremities. Accidents involving motorcycles resulted in severe injuries. Bicycle accidents not involving motor vehicles were the least dangerous, having mostly upper extremity injuries. Boys were more involved than girls in all types of accidents except motor vehicle passenger accidents. The most common type of road accident was the motor vehicle/pedestrian accident.

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 Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p146-9  
 1977; 3refs  
 Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
 Availability: In HS-021 568

HS-021 581

### SAFETY VILLAGE CONCEPT

Training of children ages four to eight as pedestrians is done by hour-long sessions in a safety village containing scaled-down streets, sidewalks, traffic lights, signs, landscaping, and night lighting. Pedal cars are used. The children are taught six safety rules by Elmer the Safety Elephant: look both ways before crossing the street; keep out from between cars; ride a bicycle safely and obey signs and signals; play in safe places, away from traffic; walk and do not run when leaving the curb; and where there are no sidewalks, walk on the left facing traffic. Children then practice riding, walking, and safety patrol work. Handouts given to each child at the end of the session include either an Elmer puppet and coloring sheets illustrating the safety rules or a booklet for the older children. In addition,

february 28, 1978

posters are provided for the classroom. The instructor is responsible for maintaining the children's interest and for making sure the session has training value and is not simply playtime. The safety village requires about 125 x 225 feet of space, an outlay of about \$13,000 to \$15,000, and community support.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p150-3

1977  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 582

#### DRIVER CONTROL IN THE TRUCKING INDUSTRY

The accident involvement rate for the motor carrier industry is the best of any highway user group due to the industry's driver control procedures and the regulations of the Bureau of Motor Carrier Safety (BMCS). Physical requirements for interstate truck and bus drivers are tougher than those for any other drivers. The BMCS has issued guidelines to help physicians specializing in industrial medicine to administer the physical exams. Motor carriers tend not to accept examination reports by family physicians. A driver may also be tested for his knowledge of Federal regulations and for his driving skill. The motor carrier must check the applicant's driving record for the past three years, although privacy laws make this difficult. Federal regulations place a limit of ten hours of driving followed by eight hours of rest. BMCS should have more staff for enforcement, however. Motor carriers have cooperative highway patrols to report both good and bad performance. Consolidated Freightways has its own road patrol system as well as a mobile training and retraining unit. They have also organized truck stop safety meetings. Although they support Federal safety regulations they feel that the industry's good safety record is due to its own voluntary safety measures.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p154-9  
1977  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 583

#### GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE

Background work included surveys of truck and bus drivers engaged in interstate commerce, of physicians examining commercial driver applicants, and of the pertinent technical literature. In addition, physicians' correspondence with the Bureau of Motor Carrier Safety was reviewed. A comprehensive guide for the physician was prepared which provides risk evaluation criteria based on medical knowledge, judgment, and experience. The goal is selection of fatigue resistant, well adjusted drivers. The physician must be familiar with job de-

HS-021 584

mands and environmental stresses of the applicant. The guide presents the exact language of pertinent Federal regulations, which require that there be no history of clinical diagnosis of diabetes mellitus, high blood pressure, or coronary insufficiency. Although standards of medical fitness are subject to interpretation, some quantitative formulae have been devised to help make objective decisions. The physician should take into account the severity of a given condition, the applicant's attitude, and significant complications.

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Contract DOT-FH-11-8274  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p160-75  
1977; 2refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 584

#### ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]

A 12-month study was made of all accidents in southwestern Ontario involving motor vehicles equipped with air brakes. The study area included several corridors of heavy commercial traffic between the U.S. and southwestern Ontario, yet not one U.S. vehicle with Federal Motor Vehicle Safety Standard (FMVSS) 121 air brakes was seen. Of 27,813 motor vehicle accidents, 827 or 3% involved air brake equipped motor vehicles. On-the-scene data obtained included truck type, vehicle identification number, nature of vehicle loading, presence of vehicle instability, brake application prior to collision, postcollision reservoir air pressure, and length of skid marks. Analysis of environmental factors showed that 76% of accidents occurred on roadways where no traffic control existed, 52% took place during dry conditions and 24% during wet conditions. As for visibility, 68% occurred during clear visibility and 73% during daylight. Collision scene was 54% at nonintersections and 20% at intersections. Involvement by type of roadway was 58% on undivided, two-lane portions, 26% on divided portions, and 10% on barrier-divided roadways. Ninety-four percent of the accidents took place on well maintained roadways, 88% on asphalt, 70% on straight and level roadways, and 67% on roadways with good surface markings. Accident occurrence is tabulated as a function of maximum posted speed versus the number of roadway lanes. Accidents broken down by time of day show that 74% took place between 8 A.M. and noon. There were 23% rear-end collisions, 12% angled collisions, and 15% sideswipe collisions. There were 46 fatalities and 330 personal injuries. Alcohol involvement was 3.9%; charges were made in 45% of the cases, and there were 1.6% hit and run tactics (50% of which were apprehended). Vehicle instability was reported in 185 vehicles. Use of occupant restraints was 15% in 1975, rising to 75% in 1976 following mandatory use

HS-021 585

legislation. Of 86 alleged defects reported, 77 were associated with air-brake equipped vehicles.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p176-87  
1977

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977. Funded by Transport Canada, Rd. and Motor Vehicle Traffic Safety Branch.  
Availability: In HS-021 568

HS-021 585

#### A STUDY OF SOME SCHOOLBUS CRASHES

The multidisciplinary accident investigation team of the Univ. of Toronto investigated 11 schoolbus accidents which occurred in the region between 1972 and 1976 to assess all environmental, vehicle, and human factors. There were four frontal impacts, two rear-end impacts, four rollovers, and one T-type intersection crash followed by rollover. In only one crash did the injuries reach the level of severe but not life-threatening. Impacts of the school buses with automobiles and light trucks did not result in much damage to the buses and did not result in many or serious injuries. In none of the rollovers was there much vehicle deformation. The most severe crash was one in which a bridge parapet intruded the left side of the bus from the front to the third row of seats; the driver and the two passengers seated in that area received only simple fractures. Other severe impacts were of a bus striking the rear of a tanker truck and a semitrailer impact to the rear of a schoolbus. The disadvantages of having students wear seat belts (improper use, creating disturbances over their use, possible facial injuries in the case of impact) may outweigh their advantages. Pupil injury within school buses is not a serious problem. Injuries tend to be very minor. Seat construction should be improved since the current male/female tubular construction tends to concentrate bending and produce breaks which expose hazardous edges. Metal connection of interior trim needs to be improved by strengthening so that it buckles rather than separates when compressed. Because vehicle occupants are young, there are less serious injuries. Padded seatbacks which yield under impact are more helpful than seat belts. Emergency exit windows should be required in addition to the emergency exit door. The driver should be required to wear a seat belt and to have a complete medical checkup annually.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p188-96  
1977

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977. Supported by Transport Canada, Rd. and Motor Vehicle Traffic Safety Branch.  
Availability: In HS-021 568

HSL 78-02

HS-021 586

#### A PROFILE OF FATAL ACCIDENTS INVOLVING ALCOHOL

The accident investigation research studies made during 1971-1975 in Boston, Mass., Baltimore, Md., Oklahoma City, Okla., and Albuquerque, N. Mex., are examined and a profile of the fatal, alcohol-related accident is developed. Single vehicle accidents are overrepresented and in multiple vehicle accidents, the alcohol involved vehicle is the striking vehicle. The accidents tend to occur between 8 P.M. and 4 A.M. on weekends, and involve older model vehicles which are probably poorly maintained. There is an increased risk that speeding or traveling too fast for conditions is involved. As for the driver, who was drinking and was responsible for the crash, he is male, between 20 and 35 years of age, has no more than a high school education, and is single, separated, or divorced. He has an increased risk of having a previous arrest for drinking while intoxicated (DWI) or of having two or more speeding violations; he may have a suspended or revoked license at the time of the crash, and is a heavy social drinker or a problem drinker. Police authorities should use the accident profile characteristics to become aware of the likelihood of alcohol involvement, and should encourage testing for alcohol of drivers involved in collisions. The Boston study suggests that a driver already identified as a potential problem because of a DWI arrest or two or three speeding violations be further screened for characteristics matching those of the driver profile and, if warranted, assigned to some remedial program.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p197-218  
1977; 16refs

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 587

#### BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES

Study of coroners' records and toxicology reports on the fatally injured drivers in British Columbia during 1974 and 1975 showed that 594 of the 721 had died within six hours of the crash and that 505 had been tested for presence of alcohol or barbiturates. At least 46% were found to be impaired, i.e. had blood alcohol levels (BAC's) of 80 mg%. Of the 197 tests for barbiturates, only five were positive. The incidence of barbiturates is comparable to that found by other studies. Decisions to perform barbiturate screenings appear to be influenced by the outcome of the alcohol screening. The practice of restricting screening to alcohol alone once alcohol has been detected is undesirable, since there is some evidence that other drugs are more likely to be detected in combination with

february 28, 1978

HS-021 591

alcohol. Use of blood samples alone for barbiturate screening is insufficient and results in underreporting of positive results.

by H. M. Simpson; R. A. Warren; D. Collard; L. Page-Valin  
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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p219-25  
1977; 11refs

Presented at the Conference, Vancouver, B.C., Canada, 15-17 Sep 1977. Data gathering and analysis supported in part by Non-Medical Use of Drugs Directorate, Health and Welfare, Canada, by Transport Canada, and by the Motor Vehicle Manufacturers' Assoc. of Canada.

Availability: In HS-021 568

HS-021 588

#### THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING- RELATED SKILLS PERFORMANCE

A clinical study was made of 12 males aged 21 to 42 in four laboratory sessions to test the effects of diazepam alone, alcohol alone, diazepam and alcohol in combination, and placebos on driving-related performance skills. The doses, for an average 170 lb subject, were about 5 mg diazepam and 4 oz of 86-proof alcohol beverage. The test battery included pursuit tracking, visual divided attention, and visual backward masking. Mean blood alcohol levels (BAC's) at the time of the pursuit tracking task were .070% for alcohol alone and .075% for the alcohol/diazepam combination. The joint tracking/visual search task was completed at a time when mean BAC's were .059% and .060% respectively. The backward masking tasks were finished as the respective BAC's were .046% and .048%. Subjective responses included 50% belief that the placebo treatment was an active one, and 75% belief that the diazepam treatment was an active one. Intoxication was greater for alcohol than for diazepam, and greatest for the combined treatment. Diazepam dose of 5 mg and a BAC of .06% produced roughly the same degree of impairment in all objective measures. The effects of alcohol and diazepam seem to be additive. There was a greater variability in impairment from diazepam than in that from alcohol. Earlier alcohol impairment studies showing that division of attention during skills performance worsens that performance are confirmed, and are extended to performance under the influence of diazepam and diazepam and alcohol combined. The impairment caused by diazepam could well be characteristic of other, similar types of tranquilizer or central nervous system depressant.

by H. Moskowitz; M. Burns  
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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p226-40  
1977; 9refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977. Sponsored by Insurance Inst. for Hwy. Safety.  
Availability: In HS-021 568

HS-021 589

#### ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN CANADA

The Alcohol Level Evaluation Roadside Tester (Alert) has been used in Alberta, Canada, since Nov 1976. Of the 1722

drivers tested between 24 Nov 1976-31 Mar 1977, 47% failed, 26% received warning responses, and 23% passed; the remaining 4% failed to cooperate in the test. Blood alcohol levels (BAC's) of less than 50 mg% were considered as passing, and levels of between 50 and 90 mg% were considered as warning level. Failure resulted in demands to take a Breathalyzer test. Comparison of BAC data with those of earlier years showed that the roadside testing devices aided police in arresting significantly more impaired drivers than in previous years and at significantly lower BAC levels than previously; subjective judgments by police often underestimated the intoxication of drivers.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p241-50  
1977; 9refs

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 590

#### ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS

A curriculum developed for educating persons convicted of driving while intoxicated (DWI) consists of four sessions of 2.5 hours each. During testing of the program, classes were held one night a week for four consecutive weeks. Instructors were chosen from professionals with graduate degrees in education, psychology, counseling, or some other behaviorally oriented discipline and were trained in values clarification techniques. Assistant instructors were off-duty police officers in civilian clothes. The approach was informal, nonthreatening, and lacking in scare tactics. The first session is designed to break down hostilities, present information about legal aspects of DWI, and describe the extent of the alcohol/traffic safety problem. The second session presents cognitive information about alcohol's effects on human abilities as they relate to the driving task. The third session deals with the symptoms of problem drinking and alcoholism. The fourth session aids the participants to make decisions which will prevent future DWI behavior. Preliminary evaluation of the program shows that there is a reduced incidence of re-arrest by those completing the program.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p251-9  
1977; 16refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 591

#### ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS

A sample of 1008 persons injured in road accidents in the Province of Quebec in 1974 was analyzed to determine the accuracy of road accident statistics, to classify victims by severi-

## HS-021 592

ty of injury, and to determine consumption of medical services and costs per victim. Data obtained from the Third-Party Liability Service of the Quebec Health Insurance Board included police reports, questionnaires completed by the victim or by friends and family, hospital reports, and medical services records. All fatal cases were notified by police but only seven of the 22 deaths were correctly notified. For the in-patients, 72.6% were correctly notified and 3.4% were not reported by the police. Only 53.5% of the out-patients were properly notified and 24.4% were not reported by the police. Correct figures were made for provincial transport statistics which appeared to underestimate the number of victims by 22%. The number of road victims is estimated to be between 70,093 and 79,600. Injury Severity Scores (ISS's) were computed for each victim. In-patients were more than three times more injured than out-patients. Pedestrians had the greatest ISS's; occupants of cars ranked second, followed by the motorcyclists and the cyclists. Fractures were the most common injury and the extremities were the region most frequently injured. A strong positive relation was found between the ISS and the period of treatment and the length of stay in hospital, confirming the relevance of the ISS for summarizing injury severity, especially in patients with multiple trauma. Average in-patient cost was \$2379 and average out-patient cost was \$117.

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Grant NH-Proj-605-1355-44  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p260-71  
1977; 7refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977. Also supported by the Quebec Health Insurance Board.  
Availability: In HS-021 568

## HS-021 592

### DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?

Reconstruction was made of a number of accidents involving knee injuries by a team of physicians and engineers who studied the accident scene, the vehicle, and the people involved to determine occupant kinematics and points of contact. Follow-up studies were made of some of the accident victims up to nine years after injury. Of the 80 knee injuries, 51 were classified as mild and were due to contact with a smooth, deformable dashboard; notably, 11 mild injuries, three moderate injuries, and one severe injury occurred in persons wearing seat belts. Moderate and severe injuries were usually caused by the knees slipping underneath the dashboard and contacting such things as a rigid steering column support, by application of axial forces on trapped knees, or by hyperextension with ligament tearing. Trauma produced in knee impact is determined by the energy actually absorbed rather than by the total energy available. Follow-up studies show that degenerative arthritis will develop in the more seriously injured knees. It will occur more frequently in patients with unstable knees following ligamentous damage than in stable knees with cartilaginous damage. In some cases it is difficult if not impossible to predict shortly after the injury which knee will develop traumatic arthritis. It is the lesser injuries of the extremities that can result in ultimate, long-term disability; recognition and

## HSL 78-02

early treatment of such injuries along with treatment of the more acute, life-threatening injuries are recommended.

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Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p272-8  
1977; 12refs  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977. Partially supported by the National Hwy. Traffic Safety Administration.  
Availability: In HS-021 568

## HS-021 593

### MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS

Study of the 54 surviving victims of spinal cord injury in motor vehicle accidents in British Columbia during a recent three-year period included analysis of the hospital record, comments of witnesses, and sometimes detailed engineering studies of the crashes. Drivers and passengers, paraplegics and quadriplegics are equally represented. There was broad distribution throughout the thoracic spine with the peak in the midthoracic area. There were associated injuries usually due to direct trauma in violent collisions or ejections in 40% of the cases; the paraplegics so afflicted tended to have significant chest and abdominal injury. Most of the accidents were single-vehicle accidents, occurring at night and on rural roads with the driver under the influence of alcohol. The occupant receiving the spinal cord injury was usually ejected from the vehicle, but the spinal cord injury may have occurred within the vehicle. There were 28 cases of flexion injury, 19 cases of compression injury, and six cases of extension injury. Victims tended to be younger adult males. There was notable lack of use of restraint systems; however, a review of damage descriptions shows that use of restraints alone without preservation of the passenger space will not prevent injury.

by Duncan McPherson; John Simpson  
Insurance Corp. of British Columbia, Canada  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p280-8  
1977  
Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.  
Availability: In HS-021 568

## HS-021 594

### INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS

Data were gathered on 487 accidents involving motorcycles and minibikes that occurred in a three-county area of New York in 1976 to analyze the extent of injuries sustained in the various physical configurations and to evaluate the performance of personal and motorbike safety equipment. Data included police accident reports, hospital injury data for autopsy reports, driver records, and driver accident reports. The most severe injuries to motorbike riders are sustained by the head, chest, and abdomen; injuries to these regions comprise about 15% of all injuries. Lower extremity injuries are most common, accounting for nearly 40% of all injuries. The

average severity of lower extremity injuries is relatively high (Abbreviated Injury Scale or AIS is 1.6). Injuries to the upper extremities account for 20% of all injuries, with an average AIS of 1.2. Head injuries were found to be more common in accidents involving only the motorcycle; their severity was about the same in these accidents as it was in motorcycle/vehicle accident configurations. The helmet was effective in alleviating head injuries. The average severity of motorcyclists' injuries was highest in head-on collisions between the motorcycle and another vehicle. The average severity of injuries in all other motorcycle/vehicle configurations was about the same as in accidents involving only the motorcycle. Average severity of injuries sustained by minibike riders was found to be comparable to that sustained by motorcycle operators. Tabulated data are presented.

by John C. Balcerak; Kathleen L. Pancione; John D. States  
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Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p289-304

1977; 4refs

Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977. Sponsored by New York State Dept. of Motor  
Vehicles.

Availability: In HS-021 568

HS-021 595

#### INVESTIGATING THE ROADWAY ENVIRONMENT

The investigator is instructed on how to determine the role of environmental elements in accident causation and severity. The environment is composed of roadway geometry, roadside conditions, and other factors. Elements of roadway geometrics include curvature, grade, roadway and lane width, sight distance, pavement crown, superelevation, pavement rutting, and transition curves. The investigator should go as soon as possible to the scene of the accident, and concentrate first on factors or items that may be removed or destroyed. Tools needed include a rolling distance recorder, camera with wide-angle, closeup, and moderate telephoto lens, cloth tape, carpenter's level, wedge, line level, plumb bob, and a short steel scale. A series of photographs of roadside features and of accident vehicles illustrates such hazards as the following: median openings or elephant traps, elimination of shoulders at bridges, faulty guardrails of various types, rigid barrier systems, both rigidly supported and breakaway sign supports, signs hidden by landscaping, utility poles in the roadway, and unexpected traffic signals. The technology is available to make great strides in environmental safety improvements, but hazardous locations have to be brought to the attention of the responsible agencies.

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Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p305-33

1977; 14refs

Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.

Availability: In HS-021 568

HS-021 596

#### THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"

An approach to investigating accidents is based on systematic examination of the vehicle, knowing in advance the nature of the injuries suffered. The vehicle should be identified, its dimensions and weights recorded, and its special equipment noted. Both exterior and interior damage should be recorded, as well as glass damage and hidden damage. Photography is a helpful tool. An estimate should be made of the condition of the vehicle before the crash. Analysis involves determination of vehicle and occupant kinematics, the Collision Deformation Classification, and the impact speed.

by John D. States  
University of Rochester School of Medicine and Dentistry,  
Rochester, N.Y.

Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p334-9

1977; 2refs

Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.

Availability: In HS-021 568

HS-021 597

#### EMERGENCY MEDICAL SERVICES

The recommended emergency medical services system that a typical community should have is described. There should be a well known method of contacting the service. The dispatcher should dispatch the proper type of unit, maintain helpful telephone contact with the caller, and be able to detect false calls. Emergency vehicles should be appropriately placed geographically and should be equipped according to recommended standards. Some units provide stabilization and transport, whereas others also provide emergency medical care similar to that available in a hospital. Manpower should be above minimum and training should be according to national Dept. of Transportation curricula. First responders such as police and fire department personnel should have some basic training in emergency medical care as well. There must be voice communication between the emergency medical technician and the physician. The program should be under the direct control of a physician. Continuing education of personnel is an important responsibility of the medical director. There must be cooperation among emergency medical services personnel, police personnel, and the hospital staff. The methods of the emergency medical services system are contrasted to those of the old style ambulance corps: in the former, the victim is stabilized and treatment begun before transporting, whereas in the latter, the victim is simply hurried to a hospital with no preliminary examination or treatment.

by Norman E. McSwain, Jr.  
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Kansas City, Kans.

Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p340-6

1977; 3refs

Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.

Availability: In HS-021 568

HS-021 598

HS-021 598

#### THE ROLE OF THE MEDICAL EXAMINER IN CRASH INVESTIGATION

Each fatal traffic accident in the U.S. is investigated by the police and by a coroner or medical examiner who certifies the cause of death on a standard death certificate. A forensic autopsy may or may not be performed. It is important, however, in the case of fatal vehicle crashes in order to determine how the injuries occurred and consequently what improvements might be made in design or regulation to prevent further fatalities. Different patterns of injury can be demonstrated in front impact, side impact, rear impact, rollover, and sideswipe crashes. Crashes should be made as survivable as possible by use of restraints and by vehicle crashworthiness; the medical examiner is encouraged to become knowledgeable about highway safety and to support safety programs.

by B. D. Blackbourne  
Office of the Chief Medical Examiner, Washington, D.C.  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p347-55  
1977

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.

Availability: In HS-021 568

HS-021 599

#### THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE

Ontario coroners are practicing physicians in various branches of medicine; they have extensive authority to investigate all sudden and unexpected deaths and all deaths occurring in prisons, institutions, and homes for children and the aged. The inquest, ordered by the coroner, is considered the preventive aspect of the coroner system in Ontario: it is open to the public and news media and is given wide publicity. As an example of the system, a fatal traffic accident and the investigation and inquest which followed it are presented. The driver of an automobile had been killed when his vehicle left the roadway, pocketed and tumbled through a guardrail, struck a bridge pillar, and came to rest on the roadway. The jury of the technical and demanding inquest determined the contributing factors of the accident to be the driver who was not wearing his seat belt and whose blood alcohol level was above the legal limit, and the guardrail system that failed to perform adequately because of obvious flaws in design and/or construction. The Ministry of Transportation and Communications responded to the jury's recommendations concerning that type of guardrail.

by Robert N. Green  
University of Western Ontario, Multi-Disciplinary Accident Investigation Team, London, Ont., Canada  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p356-66  
1977; 2refs

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977.

Availability: In HS-021 568

HSL 78-02

HS-021 600

#### FATALLY INJURED TRUCK DRIVERS

Autopsies of 68 fatally injured truck drivers were analyzed to determine type of injury and the relationship of injury type to vehicle type. Of the 68, 54 had died from impact with some portion of the occupant compartments of their trucks; only one (in a minipickup) had been wearing a seat belt. Severe intracranial injuries were noted in about half of the drivers of heavy trucks and pickups, and were the predominant injury in van drivers. Fractures of the cervical spine were concentrated among pickup drivers. Especially notable were the fractures in five pickup drivers at and below C5. The majority of drivers sustained severe injuries to the chest; rib fractures were the most common, but there was also damage to the heart, great vessels, and aorta probably due to steering column impact. About half of the drivers of heavy trucks and pickups had severe injuries to the abdomen; multiple abdominal injuries, however, were more common in heavy truck drivers. Impact with the rim of the steering wheel is implied. Existing knowledge of crash dynamics and occupant protection needs to be applied to the prevention of injuries to truck occupants. In particular, passive restraint systems need to be built into truck cabs since drivers tend not to wear belts and the steering column needs to be redesigned so that it does not concentrate decelerative forces on the chest.

by Trudy A. Karlson; Susan P. Baker; Bert F. Morton  
University of Wisconsin, Madison, Wis.; Johns Hopkins Univ., School of Public Health and Hygiene, Baltimore, Md.  
Publ: HS-021 568, "American Association for Automotive Medicine. Proceedings of the 21st Conference," Morton Grove, Ill., 1977 p367-78  
1977; 17refs

Presented at the Conference held in Vancouver, B.C., Canada, 15-17 Sep 1977. Supported by Insurance Inst. for Hwy. Safety and the Maryland Medical-Legal Foundation.

Availability: In HS-021 568

HS-021 601

#### COLLISION SEVERITY - MEASURED BY (DELTA)V

The sudden change in vehicle velocity that occurs in a fraction of a second during a collision while the primary vehicle damage is occurring is known as  $(\Delta)V$  and is an increasingly common measure of collision severity. It is determined by the difference in the velocities of the vehicles and by the ratio of the vehicle weights. Examples of rear-end collisions, head-on collisions, and angular collisions show that attempts to use such measures as impact speed or traveling speed as measures of collision severity are questionable, since the collision severity depends on the closing speed between the vehicles. Neither is vehicle damage valid as the single measure of collision severity, since in vehicle to vehicle collisions the absorption of energy tends to be unequal. Attempts to relate injury to absolute vehicle weight or vehicle weight difference are invalid since injury depends on the weight ratio involved and not the vehicle weights considered individually. Analyses that treat the injuries or other effects of collision as being due to the simple summing up of effects of vehicle weights or vehicle speeds, or any other relationship not corresponding to the relationships dictated by physics, are not valid. Other factors in defining collision severity are time duration over which the  $(\Delta)V$  takes place, the direction of the  $(\Delta)V$  experiences, and variations in the shape of the acceleration versus time curve.  $(\Delta)V$  is not a good measure of collision

february 28, 1978

HS-021 604

severity when considering rollover accidents, which are in a class by themselves.

by James F. Marquardt  
General Motors Corp., Automotive Safety Engineering,  
Warren, Mich. 48090  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p379-90  
1977; 2refs  
Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 602

#### TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS: AN OVERVIEW OF FINAL RESULTS

A trilevel accident causation study involved 2258 accidents investigated by technicians, with further study of 420 of them by multidisciplinary teams. Final causal factor tabulations are summarized, and results are presented of three special studies investigating the relationship of driver vision, knowledge, and psychological attributes to accident involvement. Human factors were identified as probable causes in more than 93% of the accidents investigated, compared with 34% for environmental factors and about 13% for vehicular factors. The leading human direct causes of accidents, and their respective probable level results, were improper lookout (23%), excessive speed (17%), and inattention (15%). Leading environmental factors were view obstructions (12%) and slick roads (10%). The leading vehicular problems involved brakes (5%) and tires and wheels (4%), with the leading specific problems being gross brake failure (3%), inadequate tread depth (3%), and side-to-side brake imbalance (2%). Vision, especially poor dynamic acuity, was found to be related to accident involvement. Personality, especially poor personal and social adjustment, was also found to be related to accident involvement. However, knowledge of the driving test was not shown to be related to accidents.

by John R. Treat  
Indiana Univ., Inst. for Res. in Public Safety, Bloomington,  
Ind.  
Contract DOT-HS-034-3-535  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p391-403  
1977  
Presented at the Conference held in Vancouver, B.C., Canada, 15-  
17 Sep 1977.  
Availability: In HS-021 568

HS-021 603

#### INCOMPATIBLE STANDARDS AND THEIR IMPLICATIONS FOR AUTOMOTIVE MEDICINE

Highway safety standards to date have been remedial in nature, employing individualized corrections to the highway, the vehicle, and the driver. Priorities have been based on economic costs rather than on system organization, resulting in standards and definitions that do not match each other. An alternative to the remedial approach is systems design. Transportation modes already having such system organization typically show low fatality rates. All standards can be planned to move toward a controlled method of operation, selected for

high reliability and least cost. Definitions should be developed for performance of the major elements of the system, and the individual incompatibilities of existing standards should be attacked. Those involved in automotive medicine could contribute by study of the following: injury criteria or standards to guide injury-reducing design; test standards for human performance compatibly related to other standardized parts of the highway system; test or performance capabilities for reliability of humans in each type of performance; and definition of operational environments that degrade the performance of the human operator. Both safety and energy conservation can be served by the systems approach.

by Henry H. Wakeland  
National Transportation Safety Board, Bureau of Plans and  
Programs, Washington, D.C.  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p404-11  
1977  
Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 604

#### THE NATIONAL ACCIDENT SAMPLING SYSTEM - A STATUS REPORT

The National Accident Sampling System (NASS) consists of 35 to 60 small teams of accident investigators throughout the U.S., under contract to the National Hwy. Traffic Safety Administration (NHTSA) to investigate a probability sample of accidents and to collect exposure data on a continuous basis. The primary objectives of NASS are to estimate and disseminate annual national totals and rates of accidents and exposure, accident causes and consequences, at a level of detail not currently available; to evaluate existing countermeasures and standards; to provide data during the field test or demonstration phase of proposed standards and countermeasures; to provide a current and detailed accident and injury causation data base suitable for establishing priorities for and assisting in the design of future countermeasures; and to monitor changes and trends in the highway safety environment. Ten sampling sites have so far been chosen, and work proceeds on establishing methodology and field protocol. The pilot test will determine the practicality of establishing accident research teams at randomly selected sites, and identify problems and the solutions associated with such new teams. The existing data collection network of the National Center for Statistics and Analysis will be integrated into NASS. Frequent communication will be maintained with the data users both inside and outside NHTSA. NASS data will be a public resource. Confidentiality of information from private citizens during interviews will be strictly guarded. It should be noted that NASS is not the same as the Multidisciplinary Accident Investigation (MDAI) program either in purpose or function.

by Charles J. Kahane; James C. Fell; Russell A. Smith  
National Hwy. Traffic Safety Administration, National Center  
for Statistics and Analysis  
Publ: HS-021 568, "American Association for Automotive  
Medicine. Proceedings of the 21st Conference," Morton  
Grove, Ill., 1977 p412-34  
1977; 9refs  
Presented at the Conference held in Vancouver, B.C., Canada,  
15-17 Sep 1977.  
Availability: In HS-021 568

HS-021 605

HSL 78-02

HS-021 605

**ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT.**  
**APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT.**  
**FINAL REPORT**

Automatic Vehicle Identification (AVI) technology is summarized for traffic management applications, including estimates of ultimate unit costs. These cost estimates are then used to develop detailed cost and effectiveness estimates of using AVI for five potential traffic management strategies (congestion pricing, traffic restraint--cordon control, traffic restraint--truck control, preferential lane usage, corridor control). AVI is a concept in which the identities of vehicles (e.g. state vehicle registration numbers) passing a particular location are extracted by an automated surveillance system. The record of each passage is transmitted to a computer for data storage and processing. For purposes of this report, each of the five candidate applications is considered completely independently as though only that particular function would be performed by the AVI technology. In any actual application of AVI, however, the AVI system would likely be used for several different functions.

by R. A. Ferlis; R. Aaron  
Peat, Marwick, Mitchell and Co., 1025 Connecticut Ave.  
N.W., Washington, D.C. 20036; Peat, Marwick and Partners,  
Toronto, Ont., Canada; Casciato, White and Associates,  
Toronto, Ont., Canada  
Contract DOT-FH-11-9198  
Rept. No. FHWA-RD-77-90; 1977; 30p 3refs  
Appendix B (AVI applications) is HS-021 605.  
Availability: NTIS

HS-021 606

**ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT.**  
**APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT.**  
**FINAL REPORT**

Whereas automatic vehicle identification (AVI) is a concept in which the identities of vehicles (e.g. state vehicle registration numbers) passing a particular location are extracted by an automated surveillance system and the record of each passage is transmitted to a computer for data storage and processing, automatic vehicle monitoring (AVM) systems permit the communication of a limited amount of information about the operational status of each vehicle in addition to the vehicle identity. AVM systems are either passive, using telemetry to produce the information, or active, transmitting information generated by the vehicle occupants. Results are presented of a detailed cost-effectiveness analysis of the application of "sharp signpost" AVM technology to traffic signal control. This application, which involves the use of automatic bus passenger counts for traffic control and signal preemption by emergency service vehicles, represents the most promising application of AVM for purposes of traffic management. Related work sponsored by the Urban Mass Transportation Administration (UMTA) in the application of AVM/AVL (automatic vehicle

location) to bus, police, and taxi fleet management is summarized. These additional uses of basic AVM/AVL technology could potentially serve to justify implementation of a multiple-use AVI/AVM system.

by R. A. Ferlis; R. Aaron  
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N.W., Washington, D.C. 20036; Peat, Marwick and Partners,  
Toronto, Ont., Canada; Casciato, White and Associates,  
Toronto, Ont., Canada  
Contract DOT-FH-11-9198  
Rept. No. FHWA-RD-77-90; 1977; 30p 3refs  
Appendix B (AVI applications) is HS-021 605.  
Availability: NTIS

HS-021 607

**A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 1. TECHNICAL REPORT.**  
**FINAL REPORT**

Findings related to the design of a simple yet accurate technique for measurement of vehicular delay on the approach to a signalized intersection are presented. Precise definitions were established for four measures of performance; they are stopped delay, time in queue delay, approach delay, and percent of vehicles stopping. Approach delay was selected as being the most representative of intersection efficiency. Four manual methods were tested in the laboratory using film taken at ten intersections. The values thus obtained were statistically compared with true values from time-lapse photography. The point sample, stopped delay procedure, and the percent of vehicles stopping method were selected as the most promising methods for practical use and were performed in the field at three sites. Correction factors were developed to allow the field results to more accurately estimate the true values of stopped delay and percent of vehicles stopping. Interrelationships among the four measures of performance were established such that approach delay could be estimated from a value for stopped delay.

by W. R. Reilly; C. C. Gardner; J. H. Kell  
JHK and Associates, 275 Fifth St., San Francisco, Calif. 94103  
Contract DOT-FH-11-8836  
Rept. No. FHWA-RD-76-135; 1976; 172p 72refs  
Rept. for Jul 1975-Sep 1976. Vol. 3 (User's Manual) is HS-021 608.  
Availability: NTIS

HS-021 608

**A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT**

Complete instructions are given for the application of two methods which lead to estimates of vehicle delay and stops on approaches to signalized intersections. It is recommended that the two methods be applied simultaneously in the field, with a minimum of one observer used for each method. The field method which yields an estimate of delay is termed the Intersection Delay Study. This technique gives an estimate of the total stopped delay, in vehicle-seconds, incurred by vehicles passing through an intersection. The study is based on a point sample of stopped vehicles. The field method which gives a measure of stops and also an estimate of total volume is termed the Percent Stopping Study. This study leads to an estimate of the number of vehicles having to make at least one

february 28, 1978

HS-802 303

stop on the intersection approach, as a percentage of the total number of vehicles entering the intersection. The same study also gives an estimate of total volume. Definitions for terms that are used in the application of the two methods are provided.

by W. R. Reilly; C. C. Gardner; J. H. Kell  
JHK and Associates, 275 Fifth St., San Francisco, Calif. 94103  
Contract DOT-FH-11-8836  
Rept. No. FHWA-RD-76-137; 1976; 34p  
Rept. for Jul 1975-Sep 1976. Vol. 1 (Technical Report) is HS-021 607.

Availability: NTIS

HS-021 609

#### HIGHWAY STATISTICS. SUMMARY TO 1975

A general historical summary of information dealing with highways, their use, and their financing includes statistical and analytical tables on motor fuel, motor vehicles, driver licensing, highway user taxation, state highway finance, highway mileage, Federal aid for highways, and highway finance data for local government. The information includes the year 1975 except for data on local government finances and goes back in time as far as possible. Data for Alaska and Hawaii are included in state summaries for 1959 and subsequent years. Data for some U.S. possessions are included in the annual issues of "Highway Statistics." Data sources include various Federal and state reports.

Federal Hwy. Administration, Hwy. Statistics Div.,  
Washington, D.C.  
Rept. No. FHWA-HP-HS-S75; 1977; 297p refs  
Availability: GPO Stock No. 050-001-00129-2

HS-021 610

#### OLDSMOBILE OPTS FOR DIESEL POWER

Diesel engine development at Oldsmobile is based on the gasoline-fueled 350-CID V-8, mainly because of dimensional similarities. Oldsmobile will manufacture 100,000 diesel engines in 1977 for its Eighty-Eights, Ninety-Eights, Custom Cruisers, and for Chevrolet's light-duty trucks. Development of the diesel engine was a response to fuel economy regulations in a way that minimized investment risk through utilization of existing technology and manufacturing facilities. Diesel hardware and auxiliary systems are described. The design of the prechamber minimizes stress of diesel combustion. It has a moderately sharp-angled passage connecting it to the clearance volume above the piston; an injector pencil nozzle is aligned vertically above its tip. The injection pump is of rotary configuration, incorporates a min/max governor, and is gear-driven directly off the camshaft. Fuel is brought from the tank by a lift pump driven by the crankshaft. The muffler is specially tuned to reduce noise of the unthrottled air flow. Cranking speed of the diesel starter is around 100 rpm, compared to the nominal 60 rpm of conventional gasoline-engine starters. A small vacuum pump actuates the heater, air conditioning, and cruise controls. The power brake system is boosted from the power steering unit. No exhaust catalysis or exhaust gas recirculation is needed for emissions control; only crankcase ventilation is used. A firewall panel is provided. No. 1 diesel fuel should be used at temperatures below 20° F to avoid the wax formation to which No. 2 fuel is prone at lower temperatures.

Oil and filter changes are recommended at intervals of 3000 miles. The diesel package has been extensively fleet tested.

by Dennis J. Simanaitis  
Publ: Automotive Engineering v85 n11 p24-7 (Nov 1977)  
1977

Availability: See publication

HS-802 302

#### THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND APPROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS

A survey conducted by the Dept. of Transportation in cooperation with states evaluates the adequacy and appropriateness of all Uniform Safety Standards established under Section 402, of Title 23 of the United States Code. Surveys were distributed to 22 Federal agencies, 55 states and territories, 43 private/public support groups, and 14 universities/individuals. A study overview contains background of the evaluation, data collection, detailed study and methodology, problem areas, and general comments. Comprehensive summaries are made of each standard, including: Periodic Motor Vehicle Inspection; Motor Vehicle Registration; Motorcycle Safety; and Driver Education and Licensing. Codes and Laws; Traffic Courts; Alcohol in Relation to Highway Safety; and Traffic Records are summarized. Other standards evaluated are: Pedestrian Safety; Police Traffic Services; Debris Hazard Control and Cleanup; Pupil Transportation Safety; and Accident Investigation and Reporting. Each Standard is reviewed in terms of evidence submitted; contribution to objective, necessity; and legislative and legal aspects. Cost effectiveness; program acceptance; and suggested Standard revisions are also detailed. Appendices present specific questions asked in the surveys, and an example of a standard review matrix. Findings indicate a general agreement that Standards do contribute to one or both the objectives contained in the Highway Safety Act of 1966. Comments on the necessity of Federal Standards note confusion over the mandate versus guidelines role of Standards. More legislative than legal problem areas are addressed in responses. Few public opinion survey results are cited by respondents; but instead are based on a lack of public outcry against implemented programs.

Safety Management Inst.  
Contract DOT-HS-6-01417  
1977; 421p  
Availability: NHTSA while stock lasts

HS-802 303

#### MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES

A collision report is made on V-1, a 1950 Crown 79-passenger school bus, which crashed at a speed of 46 mph over an off-ramp bridge rail in California, killing 29 and injuring 23 people. The bus, driven by an inexperienced driver, fell 21'7" after impacting and surmounting a left bridge rail on a right descending curve with a 175' radius. On impact the roof collapsed rearward and downward against the tops of the seats and lower window ledges. Major extrication procedures, aided by two heavy duty mobile cranes, were necessary because all exits were jammed. For 23 injuries occurring to occupants

between 14 and 25 years of age, most were to the head and chest regions, of the crushing "blunt force trauma" type with asphyxiation being a major factor in fatal injuries. Unpadded interior components contributed to major injuries. Occupants seated in the right front section received more severe injuries than those seated in the rear. Primary cause of the accident was failure of the air compressor belt, resulting in loss of constant air pressure required for proper brake action. Relevant conditions include failure of driver to monitor air pressure gauge; failure to apply maximum right steering input; loose electrical connections precluding audible low air pressure warning system from activating; and failure to apply manual emergency brake. Accident severity was increased by the abrupt short radius curve and a low wheel curb. Emergency rescue and medical services were efficient, although rescue was delayed by occupant entrapment. Recommendations are made for better driver training, more frequent vehicle mechanical inspections, compliance of buses with occupant protection standards similar to those for passenger cars, and elimination of rigid structures such as tubular struts. Also suggested are increased seatback strength, redesigned highback seats with well padded arm rests, and upgraded air brake and emergency stopping systems. Bus rollover crash resistance should be improved for preservation of interior integrity; design of short radius off-ramp curves should be reevaluated; and bridge railing height and design should be reevaluated in relation to large vehicles. Thirteen appendices include specific crash evaluation data: injury diagrams, autopsy reports, traffic collision report, driver records, interviews with occupants and witnesses, and vehicle condition reports prior to and following the collision. Also included are CHP interviews on bus and driver backgrounds, Solano County involvement, manufacturer information on later model buses, collision performance and injury report, film slide index, and collision location map.

by Baird; Sublett; Hughes; Averett  
 University of Southern California, Inst. of Safety and Systems Management, Los Angeles, Calif. 90007  
 Contract DOT-HS-6-01214  
 1977; 474p  
 Availability: NTIS

## HS-802 320

#### PROGRAM PRIORITY AND LIMITATION ANALYSIS. FINAL REPORT

Guideline criteria are provided for tolerable impacts of the Federal Motor Vehicle Safety Standards in areas of consumer cost, industrial impact, occupant convenience, and transport operational restrictions. Criteria are based on studies of public literature, surveys, and other sources. Regarding consumer cost, consumers may currently (mid 1976) accept prices up to \$300 higher than expected before they begin to adjust car size and options to price increases. At above \$500, some potential buyers may no longer buy a new car, and when approaching \$1000, potential buyers become unsure about their reaction, and buying might be strongly affected. The average amount buyers are willing to spend on additional safety equipment has increased over time to approximately \$75. Strictness of safety standards must be balanced with consumer costs to gauge overall impact of Standards. Increases in purchase price of trucks and gasoline consumption due to Safety Standards will have a negligible impact on the total cost structure of the carriers. Safety standards will impact on the automobile industry in a highly specific manner, except for their general impact on lead time. Consumers appear to be accepting lower manufac-

turing standards of occupant comfort, but regarding convenience only 5% of drivers are willing to accept performing more than one nondriving task such as seat belt fastening. Vehicle operation will probably not be restricted by higher fuel consumed by safety standards. Consumer and manufacturer attitudes and reactions must be closely monitored in order to realistically assess the impact of Motor Vehicle Safety Standards. An appendix presents a design for a car buyer's survey.

by Hans. C. Joksch; Gary Haas; Joseph C. Reidy, Jr.  
 Center for Environment and Man, Inc., 275 Windsor St.,  
 Hartford, Conn. 06120  
 Contract DOT-HS-5-01225  
 1977; 133p 197refs  
 Rept. for Jun 1975-Dec 1976.  
 Availability: NTIS

## HS-802 671

#### DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 11, 3 MAY 1976 TO 6 JUNE 1976

Analysis of earlier test results continued, the final report for Phase 1 was begun, and response was made to as many of the contract monitor's questions and comments as time allowed. Positions of the stationary cameras to be used in crash tests are sketched. Changes made to the interior of the Volvo include relocation of the floor pan and the toe board about one inch further forward, and the provision of one inch of additional knee clearance under the steel frame dash.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
 Contract DOT-HS-5-01254  
 Rept. No. PR-11; 1976; 10p  
 Availability: Reference copy only

## HS-802 672

#### DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 12, 7 JUNE 1976 TO 6 JULY 1976

Preparation of the final report for Phase 1 continues, and further response is made to questions and comments of the contract monitor. Tests with the six-year size child dummy concerned the variables of bag folding, gas supply, occupant seating position, test velocity, and bag deployment position. Tests included two types of computer simulations, static tests, and sled tests. A bag folding technique was chosen which minimized deployment loading to the dummy head. The two positions chosen for the dummy simulated a child leaning far forward in order to see out the window, and a child in a panic brake situation with its chest and head against the stored bag. Results show that while whole body accelerations are not a problem, some hazard exists if the child's head receives the primary bag deployment forces. The bag should therefore be kept low, either by location or by folding technique. Because the angled sled impact test simulated a skidded angled impact into a flat barrier rather than an angled barrier crash, test velocity is reduced by a given formula and the initial occupant motion is seen to be aligned with the velocity vector rather than with the vehicle. The vehicle and the restraint system are therefore evaluated under a nonaxisymmetric crash situation. Angularity effects should be determined by parametrically

february 28, 1978

HS-802 677

varying the sled angle at a given sled velocity; a sled text matrix is presented. Phase 1 of the contract is four to five weeks behind schedule.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-12; 1976; 15p

Availability: Reference copy only

HS-802 673

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 13, 5  
JULY 1976 TO 8 AUGUST 1976**

The final report for Phase 1 is virtually complete; response is made to questions and comments of the contract monitor. In-board cameras for crash tests will probably be located over the rear seats viewing through cutouts in the roof. Film data will be analyzed in accordance with the recommended practice of Society of Automotive Engineers (SAE) J138. Thiokol's statement of work for Phase 2 presupposes no changes in the aspirator system. Work is being done to improve the computer simulations. Phase 1 delays have mostly been remedied.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-13; 1976; 5p

Availability: Reference copy only

HS-802 674

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 14, 9  
AUGUST 1976 TO 12 SEPTEMBER 1976**

The report for Phase 1 was delivered, a presentation was made to the National Hwy. Traffic Safety Administration, the schedule for Phase 2 was prepared, components were ordered for the Volvo-Eaton driver airbag tests, and computer simulations were run of sled runs 1545 and 1547. Funds expended through 5 Sep 1976 were \$184,511 not including fee; estimated expenditures were \$183,014. The computer simulations used a new technique for developing parameters of the aspirated inflator gas-dynamic characteristics and also included detailed geometry of the shape and deployment of the FIX-4 air bag. Comparison of the simulations to the actual sled tests show the improved agreement.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-14; 1976; 10p

Availability: Reference copy only

HS-802 675

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 15, 13  
SEPTEMBER 1976 TO 10 OCTOBER 1976**

Hardware necessary for the driver airbag tests has been received, preliminary computer simulations have been run of oblique impacts, and a purchase order has been issued to

Thiokol for Phase 2 aspirator system support. In addition, study continues on conditions to be selected for the oblique impact sled simulation runs, and a review of the literature has been made with regard to definition of the vertical, severity index, injury criterion, and acceleration tolerance.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-15; 1976; 4p

Availability: Reference copy only

HS-802 676

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 16, 11  
OCTOBER 1976 TO 7 NOVEMBER 1976**

Conditions were selected for offset crash simulations, Volvo 45 mph crash data were analyzed to determine time of firewall intrusion, a passenger kneebar system was installed in the Volvo, and modifications of the Volvo sled buck were begun for the driver airbag tests. Firewall intrusion data show that intrusion occurs primarily over the period of 40 to 70 msec, and that femur loads peak during the intrusion period but maximum chest resultant acceleration occurs later. Femur loads should not be increased since the honeycomb knee bar is a load-limiting design. Various offset crash simulations have the following characteristics in common when compared with an aligned, car to car frontal crash: greater deformation on the impacted side, longer duration crash pulse, and lower peak deceleration pulse. Data are presented from a Volvo to Ford offset car crash.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-16; 1976; 14p

Availability: Reference copy only

HS-802 677

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 17, 8  
NOVEMBER 1976 TO 5 DECEMBER 1976**

A Volvo 244 frontal barrier crash test was run with driver and front passenger airbag restraint systems, as was a series of driver airbag sled tests. In addition, several types of static-crash bench tests were conducted on the Volvo steering wheel and column, and all Thiokol components for the evaluation sled test series have been shipped to Calspan. The Volvo 244 car crash test, data for which are appended, was a flat-faced fixed barrier crash at 41.6 mph with 50th percentile, adult male dummies. The driver restraint system was an Eton Corp. air bag mounted in a Volvo sport-type steering wheel with a Volvo production knee bar; the front passenger restraint was the Calspan aspirator airbag system using a Thiokol gas generator with an aluminum honeycomb knee restraint designed by Calspan. The driver airbag system did not provide tolerable results with regard to present injury criteria. Sled tests were made of that airbag system to determine what improvements could be made; data for the tests are appended. It appears that a driver bag will not be capable of maintaining support of the occupant's head in the oblique case. Suggested modifications include padding of the A pillar and improved upper torso lateral restraint. A simple quasistatic axial com-

HS-802 678

pression test was conducted to determine the crush properties of the Volvo energy-absorbing steering column. It crushed at a fairly uniform level with a mean value of about 900 lbs; maximum stroke length prior to bottoming out was four inches. Results of two simple crush tests of the sport steering wheel are appended; configurations approximated pure axial impact motion and pure translational impact motion. Results suggest that occupant kinematics may influence wheel performance.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-17; 1976; 90p  
Availability: Reference copy only

HS-802 678

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 18, 6  
DECEMBER 1976 TO 9 JANUARY 1977**

Analysis continued of car crash test data and driver sled test data; computer simulations were finished; and bench tests were made of dummy femur loading. In addition, an evaluation sled test program was begun which included static bag inflation tests, and the existing Volvo sled buck was modified into a hybrid, part boiler plate and part actual vehicle, sled buck. Data analysis of the car crash test showed that performance of the aspirator airbag system was excellent with the exception of a left femur load of 2200 lbs. Data for the sled tests include head injury criteria values, which are tabulated. Static tests of the aspirator airbag inflator, data for which are presented, are not yet fully analyzed. Sled tests were run at the baseline crash test condition with 50th percentile male dummies in normal position, 46 mph. Although analysis is not yet final, results suggest a problem with repeatability. Bench tests of dummy femur loading show that the high femur loading of the crash tests was caused by the kneebar setup. A report on the computer simulations is appended. In order to continue simulation of an oblique 20° impact configuration, several program modifications are necessary. Validation of the simulated Volvo barrier crash was conducted informally, without use of contract funds; data are presented.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-18; 1977; 30p  
Availability: Reference copy only

HS-802 679

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 19, 10  
JANUARY 1977 TO 13 FEBRUARY 1977**

The evaluation sled test program continued with 18 additional runs; results have not yet been reduced or analyzed sufficiently for a report to be made. So many evaluation sled tests had to be run to evaluate the new lightweight aspirator hardware that there might not be enough runs left to provide an adequate data base.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-19; 1977; 4p  
Availability: Reference copy only

HSL 78-02

HS-802 680

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 20, 14  
FEBRUARY 1977 TO 13 MARCH 1977**

Results of static deployment tests and sled tests were analyzed, and plans made for the remaining evaluation sled tests. A series of examinations and tests shows that there is no significant difference between the old and the new aspirator systems. However, a small variation in bag folding was having a relatively strong effect on bag deployment static pressure and thus was affecting the results of the static child-hazard tests. Static firings were made with the six-year size child dummy in three different forward positions to simulate a child sitting forward on the edge of the seat to see well out of the windshield, a child who has slid forward in a panic braking situation, and a child with legs just breaking over the seat front and the head contacting the dash (a worst case situation). The dummy positions increase in hazard in the order given. All positions are sensitive to bag folding technique. Airbag venting on the right hand side is unacceptable due to unpredictable blockage by the right front door and camera. Results of tests on adult dummies are extremely sensitive to bag venting. The center vent should be relocated. The new, lightweight aspirator system must be finely tuned in order to obtain acceleration data which satisfy present injury criteria at 46 mph. Velocity limit could be extended by providing improved ridedown. The nine runs described in an earlier informal submission should be conducted and their results evaluated; this could be done without requesting additional contract funds.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-20; 1977; 19p  
Availability: Reference copy only

HS-802 681

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 21, 14  
MARCH 1977 TO 10 APRIL 1977**

A meeting was held at the National Hwy. Traffic Safety Administration to review the status of the program, a test plan was submitted for the next series of evaluation sled tests, and a purchase order was issued to Thiokol for 14 gas generators. Completion of the evaluation sled test series will be delayed about eight weeks due to very heavy commitment of the sled facility during Mar-May.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-21; 1977; 4p  
Availability: Reference copy only

HS-802 682

**DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 22, 11  
APRIL 1977 TO 1 MAY 1977**

The test plan for the next series of evaluation sled tests was resubmitted, and the 14 gas generators were received from

february 28, 1978

Thiokol. Completion of the evaluation sled test series will be delayed about ten weeks due to very heavy commitment of the sled facility during Mar-May.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-22; 1977; 3p  
Availability: Reference copy only

HS-802 683

**DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 23, 2 MAY 1977 TO 5 JUNE 1977**

The evaluation sled test series was completed; interim results of the series-3 tests are tabulated. Results were satisfactory with regard to kinematics. As for injury criteria, at 46-47 mph the results were generally acceptable although the chest results for the adult 50th percentile male dummies were borderline; this test condition appears to be the upper limit capability of the system. The velocity limit of protection is probably 45 mph for that dummy and 40 mph for the larger adult. Injury data for the child dummy in the forward position are erroneously high since the dummy's forehead struck the dash which in the test was made of rigid boiler plate. Two runs made specifically to reveal any differences between Phase 1 and Phase 2 systems showed that there were differences in either bag fill (inflation) or bag empty (venting) which affected results. Tests made to determine repeatability for the 50th percentile and six-year dummies, results of which are tabulated, showed some differences for the 50th percentile dummy. The system appears to provide satisfactory occupant protection up to a frontal barrier crash velocity of about 45 mph, and appears to give superior protection to the small child both seated normally and out of position.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-23; 1977; 8p  
Availability: Reference copy only

HS-802 684

**DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 24, 6 JUNE 1977 TO 10 JULY 1977**

The only activity was discussion of future work. Final contract funds will be used for six to eight sled tests and for one car-to-car, Volvo-to-Volvo, crash test at a closing speed of about 80 mph; configurations and dummies to be used are tabulated.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-24; 1977; 4p  
Availability: Reference copy only

HS-802 685

**DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT**

HS-802 687

**SEAT PASSENGER. PROGRESS REPORT NO. 25, 11 JULY 1977 TO 14 AUGUST 1977**

The only activity was discussion of the final sled tests and crash test to be done in Sep and Oct. The sled tests will include two runs made with the knee restraint moved two inches toward the firewall, three runs with the six-year size child dummy and an actual Volvo dash panel, and one test with the 95th percentile adult male dummy. The knee restraint position for the car crash will be selected on the basis of sled test results. The knee restraint pan will be reinforced and bolted to reduce the knee restraint loading which is carried into the dash panel. Some upward movement of the steering column may be unavoidable without adding major structural support to the column itself, due to direct loading of the occupant's torso through the air bag.

Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01254  
Rept. No. PR-25; 1977; 6p  
Availability: Reference copy only

HS-802 686

**EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED**

The crash test was performed to determine cadaver performance as an airbag restrained right front passenger to compare with both a belt restrained cadaver right front passenger and airbag and belt restrained anthropomorphic dummy right front passengers in identical crash situations. In addition, dummy performance as airbag and belt restrained drivers was monitored. The vehicles were 1973 Chevrolet Impalas, one with air cushion restraint systems. Data presented include before and after photos, high speed movie camera information, sketch and measurements of exterior damage, passenger compartment intrusion, electronic data and instrumentation, occupant injury criteria values, and X-ray and autopsy findings. Calman 19, riding as an airbag restrained right front passenger, was assigned an abbreviated injury scale rating of two (AIS 2) because of a spiral fracture of the right tibia. All injury criteria of Federal Motor Vehicle Safety Standard (FMVSS) 208 were met.

by Michael J. Walsh  
Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-6-01470  
Rept. No. ZM-6049-V-6; 1977; 91p  
Availability: Reference copy only

HS-802 687

**PASSIVE SEAT BELT STUDY. MONTHLY PROGRESS REPORT NO. 2**

The state of the art in passive seatbelt systems research and development was determined by a literature search, investigations of hardware systems, and interviews of individuals who have been involved in such research and development. The most significant piece of literature was an interpretive review of comments made by owners of those Volkswagens (VW's) having passive seatbelt systems; the review is appended.

Preliminary results of the interviews show that the most highly rated passive system is one in which the anchor points are in the lower left corner of the door, inboard of the seat, and overhead/outboard; the belt is one continuous web, and ingress and egress are nearly unrestricted. After mockup evaluations were made of various webbing configurations, the following five systems were chosen for further study: the production VW two-point system; a modified VW two-point system; a simple, nonmotorized three-point system plus manually effected convenience hook; the optimum motorized three-point system utilizing automatic convenience devices both inboard and outboard; and an experimental, optimized system as yet to be specified. Fifteen design objectives are formulated. The Ford Fiesta is recommended as the vehicle test bed. The questions used for evaluation should deal with door opening, getting into the vehicle, adjustments to the webbing before settling down to drive, mobility while driving, getting out of the car, exiting from the door on the other side of the car, and emergency escapes. The various systems will be judged first in pairs, then overall. Subjects will include a child under age ten, a pregnant female, a prosthetically handicapped individual, and a uniformed police officer. Vehicle test beds will be purchased; the restraint systems except for the production system will be fabricated. The basic experimental design will be a three-way factorial design with replications.

Man Factors, Inc., 4433 Convoy St., Suite E, San Diego, Calif. 92111  
 Contract DOT-HS-01617  
 Rept. No. PR-2; 1977; 43p 40refs  
 Rept. for Sep 1977. Contains Interim Report No. 1: a state of the art review, by W. E. Woodson, MFI-77-112(R).  
 Availability: Reference copy only

**NATIONAL HIGHWAY TRAFFIC SAFETY  
 ADMINISTRATION, TRUCK AND BUS SAFETY  
 SUBCOMMITTEES. TRANSCRIPT OF  
 PROCEEDINGS, WINSTON-SALEM, NORTH  
 CAROLINA, MONDAY, SEPTEMBER 19, 1977**

A meeting on Federal Motor Vehicle Safety Standard (FMVSS) 121, Air Brake Systems, concerns on-site visits to brake inspection stations made by committee members to determine the reaction to servicing FMVSS 121 brakes. The site visits were made at the following industrial locations: Roadway Express (Baltimore, Md.), Piedmont Ford, McLean Trucking Co., GMC Truck Center, Burlington Industries, International Harvester, International Brotherhood of Teamsters, Mid-West Freight Lines, Pacific Intermountain Express (Akron, Ohio), Leeway Motor Freight (Oklahoma City, Okla.), and Davidson and Motor Freight (Baltimore). A report is made on the status of FMVSS 121 brakes in California, as understood by study of inspection data from the California Hwy. Patrol for a two-month period. About 20% of heavy duty commercial vehicles in California are FMVSS 121 equipped; about 22% of the antilock equipped brakes were obviously inoperable, and a total of 75% had one or more violations or defects. Ms. Claybrook reported on the status of FMVSS 121. A report by Heavy Duty Trucking was read concerning the feasibility and practicality of preparing a general FMVSS 121 brake system mechanic's manual. The report dealt with inspection procedures, componentry, troubleshooting procedures, and test equipment. There seems to be enough in common among the various systems to make a general maintenance manual useful; it should include reference tables for those test values

and procedures which are not common to all systems. Attachments to the transcript include the following: a report of a survey of drivers, supplied by Chauffeurs, Teamsters and Helpers Local 391; interview questions for on-site FMVSS 121 fleet visits; a letter giving the experience of Milne Truck Lines with FMVSS 121 brakes; and some of the statistics from the California Hwy. Patrol data.

1977; 156p

See also HS-802 690.

Availability: Reference copy; Acme Reporting Co., 1411 K St., N.W., Washington, D.C. 20005

**NATIONAL HIGHWAY TRAFFIC SAFETY  
 ADMINISTRATION, TRUCK AND BUS SAFETY  
 SUBCOMMITTEES. TRANSCRIPT OF  
 PROCEEDINGS, WINSTON-SALEM, NORTH  
 CAROLINA, TUESDAY, SEPTEMBER 20, 1977**

A meeting on Federal Motor Vehicle Safety Standard (FMVSS) 121, Air Brake Systems, consisted of presentations of several reports and recommendations. A representative of the subcommittees reported on the concept of antilock, noting its nonfailsafe nature and recommending deletion of the "no lock-up" provisions of FMVSS 121. A member of the National Hwy. Traffic Safety Administration (NHTSA) reported on NHTSA activity to increase training of mechanics concerning FMVSS 121 servicing. The independent operator is in need of a simplified maintenance manual such as the one being written by the subcommittees. Manufacturers' training programs are going begging for students. A road-show type of training program is being considered. A report was made on two fatal accidents in Utah which involved trucks with FMVSS 121 brake systems. A report was made on the progress to date of the Hwy. Safety Res. Inst. study which is monitoring 3200 trucks (having air brakes and manufactured between Jan 1974 and Jan 1977) over a period of two years to gather data on mileage, maintenance, and accidents. A status report is presented on NHTSA-sponsored evaluation studies of the Courtesy Inspection Program. A motion made to recommend that tractors and trailers have identification visually identifying them as FMVSS 121-equipped was rejected. A motion was made that the lock-up provision of FMVSS 121 be deferred until the system is further developed and proved successful by a representative number of fleets; it was carried.

1977; 229p

See also HS-802 689.

Availability: Reference copy; Acme Reporting Co., 1411 K St., N.W., Washington, D.C. 20005

**VEHICLE INTEGRATION AND EVALUATION OF  
 PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
 REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON**

Test No. 1 to study the performance of advanced restraints during a high speed frontal car-to-car collision when integrated into a crashworthy small production automobile used two 1976 Volvo 244's impacting head-on, zero degree angle, 80 mph. One of the vehicles was equipped with advanced belt restraint systems and the steering column and instrument panel removed; the other was structurally modified in the dash area to accept the Research Safety Vehicle (RSV) airbag restraint

february 28, 1978

HS-802 697

systems for both driver and passenger. Preliminary data, graphed and tabulated, include data for vehicles and injury criteria data for the dummies.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
(n.d.); 26p  
Availability: Reference copy only

HS-802 692

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON**

Two 1976 Volvo 244's were impacted head-on at a closing speed of 80 mph to determine the performance of the restraints. The first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems. The second car was equipped with advanced belt restraint systems, with steering column and instrument panel removed, then the dash reinstalled to preserve occupant compartment geometry. Both vehicles were reinforced in the floor pan area. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-02; (n.d.); 30p  
See also HS-802 691 and HS-802 694--HS-802 708.  
Availability: Reference copy only

HS-802 693

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON**

Two 1976 Volvo 244's were impacted head-on at a closing speed of 90 mph to determine the performance of the restraints. The first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems. The second car was equipped with advanced belt restraint systems, with steering column and instrument panel removed, but with no structural modifications to the dash. Both vehicles were reinforced in the floor pan area. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-03; (n.d.); 29p  
See also HS-802 691, HS-802 692, and HS-802 694--HS-802 708.  
Availability: Reference copy only

HS-802 694

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET**

Two 1976 Volvo 244's were impacted offset to the right at a closing speed of 80 mph to determine the performance of the restraints. The first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems.

The second car was equipped with advanced belt restraint systems, with steering column and instrument panel removed, then the dash reinstalled to preserve occupant compartment geometry. Both vehicles were reinforced in the floor pan area. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-04; (n.d.); 29p  
See also HS-802 691--HS-802 693 and HS-802 695--HS-802 708.  
Availability: Reference copy only

HS-802 695

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET**

Two 1976 Volvo 244's were impacted offset to the right at a closing speed of 80 mph to determine the performance of the restraints. The first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems. The second car was equipped with advanced belt restraint systems, with steering column and instrument panel removed, then the dash reinstalled to preserve occupant compartment geometry. Both vehicles were reinforced in the floor pan area. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-05; (n.d.); 35p  
See also HS-802 691--HS-802 694 and HS-802 696--HS-802 708.  
Availability: Reference copy only

HS-802 696

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 6. TEST TYPE: CAR-TO-BARRIER**

Two 1976 Volvo 244's were impacted into a barrier at a speed of 45 mph to determine the performance of the restraints. The first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems. The second car was equipped with advanced belt restraint systems, with steering column and instrument panel removed, then the dash reinstalled to preserve occupant compartment geometry. Both vehicles were reinforced in the floor pan area. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-06; (n.d.); 28p  
See also HS-802 691--HS-802 695 and HS-802 697--HS-802 708.  
Availability: Reference copy only

HS-802 697

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 7. TEST TYPE: CAR-TO-BARRIER**

Two 1976 Volvo 244's were impacted into a barrier at a speed of 48 mph to determine the performance of the restraints. The

HS-802 698

HSL 78-02

first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems. The second car was equipped with advanced belt restraint systems, with steering column and instrument panel removed, then the dash reinstalled to preserve occupant compartment geometry. Both vehicles were reinforced in the floor pan area. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-07; (n.d.); 28p  
See also HS-802 691--HS-802 696 and HS-802 698--HS-802 708.  
Availability: Reference copy only

HS-802 698

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON**

A 1976 Volvo 244 and a 1975 four-door Ford Torino were impacted head-on at a closing speed of 80 mph to determine the performance of the restraints. The Volvo was structurally modified and equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems, and was reinforced in the floor pan area. The Ford was equipped with the standard, factory-installed, three-point belt restraint systems. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-08; (n.d.); 39p  
See also HS-802 691--HS-802 697 and HS-802 699--HS-802 708.  
Availability: Reference copy only

HS-802 699

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON**

A 1976 Volvo 244 and a 1975 four-door Ford Torino were impacted head-on at a closing speed of 80 mph to determine the performance of the restraints. The Volvo was structurally modified in the dash and firewall area to minimize occupant compartment intrusion, and was equipped with an air belt for the driver and a force limited belt for the passenger. The Ford was equipped with standard, three-point belt restraint systems with webb-locking devices at the D-ring location. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-09; 1977?; 43p  
See also HS-802 691--HS-802 698 and HS-802 700--HS-802 708.  
Availability: Reference copy only

HS-802 700

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT**

A 1976 Volvo 244 and a 1975 four-door Ford Torino were impacted on the right side at a 30° angle and a speed of 60 mph to determine the performance of the restraints. The Volvo was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems, and was reinforced in the floor pan area. The Ford was equipped with the standard, factory installed, three-point restraint systems. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-10; 1977?; 35p  
See also HS-802 691--HS-802 699 and HS-802 701--HS-802 708.  
Availability: Reference copy only

HS-802 701

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT**

A 1975 Volvo 244 and a 1975 four-door Ford Torino were impacted on the left side at an angle of 30° and a speed of 60 mph to determine the performance of the restraints. The Volvo was structurally modified in the dash and firewall area to minimize occupant compartment intrusion, and was equipped with an airbelt for the driver and a force limited belt for the passenger. The Torino was equipped with standard three-point belt restraint systems with webb-locking devices at the D-ring locations.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-11; 1977?; 43p  
See also HS-802 691--HS-802 700 and HS-802 702--HS-802 708.  
Availability: Reference copy only

HS-802 702

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT**

A 1976 Volvo 244 and a 1975 four-door Ford Torino were impacted on the right side at an angle of 30° and a speed of 63.5 mph to determine the performance of the restraints. The Volvo was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems, and was reinforced in the floor pan area. The Ford was equipped with the standard factory installed, three-point belt restraint systems with webb-locking devices at the D-ring locations. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-12; (n.d.); 41p  
See also HS-802 691--HS-802 701 and HS-802 703--HS-802 708.  
Availability: Reference copy only

february 28, 1978

HS-802 708

HS-802 703

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT**

A 1976 Volvo 244 and a 1975 four-door Ford Torino were impacted head-on with a 30° angle to the left at a closing speed of 65 mph to determine the performance of the restraints. The Volvo was structurally modified and equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems, and was reinforced in the floor pan area. The Ford was equipped with the standard, factory installed, three-point belt restraint systems. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-13; (n.d.); 40p  
See also HS-802 691--HS-802 702 and HS-802 704--HS-802 708.  
Availability: Reference copy only

HS-802 704

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT**

A 1976 Volvo 244 and a 1975 four-door Ford Torino were impacted at a 30° angle on the right side to determine the performance of the restraints. The Volvo was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems, and was reinforced in the floor pan area. The Ford was equipped with the standard, factory installed, three-point belt restraint systems. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-14; (n.d.); 43p  
See also HS-802 691--HS-802 703 and HS-802 705--HS-802 708.  
Availability: Reference copy only

HS-802 705

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON**

Two 1975 four-door Ford Torinos were impacted head-on at a closing speed of 75 mph to determine the performance of the restraints. Both cars were equipped with the standard, factory installed, three-point belt restraint systems with force limiters. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-15; (n.d.); 7p  
See also HS-802 691--HS-802 704 and HS-802 706--HS-802 708.  
Availability: Reference copy only

HS-802 706

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT**

A 1976 Volvo 244 and a 1975 four-door Ford Torino were impacted at a 45° angle on the left side at a speed of 60 mph to determine the performance of the restraints. The Volvo was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems, and was reinforced in the floor pan area. No restraints were used in the Ford. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-16; (n.d.); 7p  
See also HS-802 691--HS-802 705, HS-802 707, and HS-802 708.  
Availability: Reference copy only

HS-802 707

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON**

Two 1976 Volvo 244's were impacted head-on at a closing speed of 85 mph to determine the performance of the restraints. The first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems. The second car was equipped with advanced belt restraint systems, with steering column and instrument panel removed, then the dash reinstalled to preserve occupant compartment geometry. Both vehicles were reinforced in the floor pan areas. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-17; (n.d.); 7p  
See also HS-802 691--HS-802 706 and HS-802 708.  
Availability: Reference copy only

HS-802 708

**VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET  
LEFT**

Two 1975 Volvo 244's were impacted offset to the left by 25 inches at a closing speed of 80 mph to determine the performance of the restraints. The first car was equipped with Research Safety Vehicle (RSV) driver and passenger airbag restraint systems, and was reinforced in the floor pan area. The second car was not equipped with any restraint system, nor were any structural modifications made. Preliminary test data are graphed and tabulated.

Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-6-01307  
Rept. No. Test-18; (n.d.); 12p  
See also HS-802 691--HS-802 707.  
Availability: Reference copy only

HS-802 709

HS-802 709

**EVALUATION OF TEST DUMMY'S FLESH PARTS  
PRODUCED WITH SUBSTITUTE FOAMING  
COMPOUNDS. PROGRESS REPORT NO. 7, 1  
SEPTEMBER TO 30 SEPTEMBER 1977**

Part 572 component tests of two Alderson Res. Labs. (ARL) Nitrosan dummies were completed according to the specifications in 49 CFR-Part 572, revised in Docket 73-08, Notice 4. Tabulated data are presented for tests of head drop, head/neck, thorax impact, lumbar spine flexion, abdomen press, and femur impact. All test results conform to applicable performance requirements. Additional expense for sled setup and test preparation may result if tests of the Humanoid Compound A skins cannot be performed as planned.

by Daniel E. Massing  
Calspan Corp., Buffalo, N.Y. 14221  
Contract DOT-HS-6-01514  
Rept. No. PR-07; 1977; 11p

Availability: Reference copy only

HS-802 713

**TESTING OF VEHICLE SPEEDOMETERS AND  
ODOMETERS FOR ACCURACY. FINAL REPORT**

The feasibility and practicability of the Notice of Proposed Rulemaking Docket 76-06, Notice 3, was investigated by gathering performance data on a sampling of 1977 model vehicle speedometers and odometers. The following vehicles were used: Chrysler LeBaron and New Yorker; Plymouth Volare; Oldsmobile Cutlass and Delta 88; Ford F-150 pickup, LTD II station wagon, Pinto, and LTD II sedan; Buick Regal; Pontiac Catalina; Chevrolet Nova, Impala, and Vega; Datsun B210; and Volkswagen Beetle. In the track tests, each vehicle was tested for 100 miles at speeds of 30, 40, and 55 mph; the driver maintained a constant speed using the speedometer rather than cruise control. Vehicles were instrumented with a fifth wheel. The Chevrolet Nova and Vega were retested with tires worn to 20% tread. Bench tests were also performed for all vehicles. Road tests were made of the Chevrolet Impala and Vega. Data include fifth wheel data taken by photographs and tabulated, photographs of a typical 100 mile test, track test data in data sheet form, and tabulated data summaries. Results show that only two of the vehicles (Ford LTD II sedan and Pontiac Catalina) were out of the specified tolerance of plus or minus 4 mph in the speedometer and only the Ford LTD II sedan was out of the specified tolerance of plus or minus 4% in the odometer. The bench test can reveal problems in the speedometer, odometer, and cable but not problems in the overall system. The track tests could have been reduced to 50 miles.

by Anthony R. Bayer; Russell L. Kirkbride  
National Hwy. Traffic Safety Administration, Engineering  
Test Facility, P.O. Box 37, East Liberty, Ohio 43319  
Rept. No. OCA-577-1; 1977; 75p  
Rept. for May-Sep 1977.

Availability: Reference copy only

HSL 78-02

HS-802 715

**KANSAS CITY, MISSOURI ALCOHOL SAFETY  
ACTION PROJECT. ANNUAL REPORT NO. 1,  
JANUARY 1-DECEMBER 31, 1972**

The Kansas City, Mo., Alcohol Safety Action Proj. (ASAP) went into operation 1 Jan 1972. While the project's ultimate goal was to reduce the number of injuries and fatal crashes resulting from the use of alcohol, the daily effort was to get drunk drivers off the streets, identify the problem drinkers, and educate or rehabilitate those on probation, as the need existed. A Special Alcohol Safety Patrol unit of seven officers trained in the use of breathalyzers and videotape equipment patrolled on a random, selective enforcement basis. Court records of persons charged with driving under the influence (DUI) were provided to the ASAP data bank. The Probation Staff Office conducted both pretrial screening and presentence investigations; recommendations were submitted to the court. ASAP probation is usually one to two years in length. The School for Alcohol Safety dealt with both large groups (social drinkers) and small groups (problem drinkers). The Antabuse activity was administered by the Kansas City Health Dept. Court case backlog of two to three months was reasonable. Computerization of the ASAP pretrial screening reports was helpful. Many rehabilitation referrals were made to the Comprehensive Community Treatment Programs for Alcohol Problems of Kansas City, Inc., grant agencies of the National Inst. of Alcohol Abuse and Alcoholism. There were 1900 cases referred to probation counseling. Problems included the absence of driver histories in the pretrial screening reports, "no shows" in the School for Alcohol Safety, and overworked probation personnel.

Kansas City Alcohol Safety Action Proj., 414 East 12th St.,  
Kansas City, Mo. 64106  
Contract DOT-HS-077-1-100  
Rept. No. KCASAP-AR-1; 1973?; 75p  
See also HS-802 716-HS-802 731.  
Availability: Reference copy only

HS-802 716

**KANSAS CITY ALCOHOL SAFETY ACTION  
PROJECT. 1972 HOUSEHOLD OPINION AND  
ATTITUDE SURVEY**

A total of 542 randomly selected persons completed the interview during the Sep/Oct 1972 survey of attitudes toward alcohol and traffic safety. As in a 1971 survey, the general public was not found to be very knowledgeable on the subject of drinking and driving. Most of the respondents (80%) were drivers, over half (64.5%) drank alcoholic beverages, and nearly one third (30.1%) admitted to driving after having drunk alcoholic beverages. However, there was no indication that they knew how much alcohol is required to impair driving ability and few (27%) knew what the presumptive limit is. In addition, the majority believed that social drinkers are the principal menace on the highway. About one half believed they had never personally encountered a drunk driver; one third said they had a traffic accident or a moving violation arrest in the past three years. These facts suggest that without a successful public education campaign, it is doubtful if the community support, required for a successful Alcohol Safety Action Proj. (ASAP), can be obtained. About 75% of the people indicated they would support most countermeasures aimed at the drunk driver although they were skeptical of countermeasure effectiveness. Forty-four percent of those asked said

february 28, 1978

HS-802 719

they would not be willing to pay extra taxes in an effort to reduce alcoholrelated traffic accidents (results essentially identical to 1971 survey). The greatest change was an increased awareness of the presumptive limit for intoxication. At best it appears that the first year's public relations effort has influenced about 3% of the population; however, the effort was directed primarily at special interest groups through the Speaker's Bureau. The following areas for education of the general public are considered of prime importance: the meaning of blood alcohol concentration (BAC) as it relates to driving impairment; the effects of alcohol on the body; the distinction between social and problem drinkers, attributes of problem drinkers, and the fact that the majority of drunk driving is done by problem drinkers; the concepts of accident risk and accident probabilities; and risks and benefits of the use of Antabuse.

by George A. Beitel; Michael C. Sharp; William D. Glauz  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-SR-7; 1973; 28p 2refs  
Prepared under subcontract to City of Kansas City, Missouri;  
see also HS-802 715, HS-802 717--HS-802 731.  
Availability: Reference copy only

HS-802 717

**KANSAS CITY ALCOHOL SAFETY ACTION  
PROJECT. AN ANALYSIS OF THE SPECIAL  
ALCOHOL SAFETY PATROL. ANNUAL REPORT  
NO. 1 (PT. 3)**

The Special Alcohol Safety Patrol (SASP) of the Kansas City, Mo., Alcohol Safety Action Proj. (ASAP) is comprised of a seven-man unit within the Kansas City, Mo., Police Dept. (KCMOPD). It conducts the enforcement activity of the Kansas City ASAP. The objective of the unit is to detect and arrest drunk drivers. During the first year (1972) SASP made 1535 arrests for driving under the influence (DUI), an equivalent of 256 arrests per man-year. The SASP unit increased the size of the KCMOPD force by 0.6% over the previous year. They personally increased total traffic arrests by 6% and the DUI arrest total by 60%. The SASP officers, working one to a car, patrol throughout the city between 7:00 P.M. and 3:00 A.M., although initially the shifts were 10:00 P.M. to 6:00 A.M. The arrest rate was found to peak at 1:30 A.M., and the greatest number of arrests occurred in bar areas. On the average, it took 5.7 hours of patrol time per arrest. The typical person arrested by SASP was a white male, 30-40 years old, a resident of Kansas City, and having a BAC of 0.173%. At the end of the first year of ASAP, SASP is considered to have performed admirably well. The only area of significant departure from the original plan has been a steady decline in the use of video tape to record arrests. However, this is not considered a serious problem because the high quality of SASP arrests precludes the necessity of a video tape being used as convincing evidence in court.

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City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-AR-1-Pt-3; 1973; 27p  
Rept. for 1 Jan-31 Dec 1972. Prepared under subcontract to  
City of Kansas City, Mo. See also HS-802 715, HS-802 716,  
HS-802 718--HS-802 731.  
Availability: Reference copy only

HS-802 718

**KANSAS CITY ALCOHOL SAFETY ACTION  
PROJECT. 1973 HOUSEHOLD OPINION AND  
ATTITUDE SURVEY**

A total of 510 randomly selected persons completed the interview during the Sep/Oct 1973 survey of attitudes toward alcohol and traffic safety. In general, results were quite similar to those of previous surveys. Most of the respondents (85%) were drivers, 67% drank alcoholic beverages, and 36% admitted to driving after drinking. About half (51%) named alcohol as the major factor in fatal crashes, reflecting a gradual increase in knowledge of this fact. However, there was no indication that they knew how much alcohol is required to impair their driving ability. Only 13% knew the presumptive limit (in contrast to 27% in 1972). In addition, the majority still incorrectly believed that social drinkers are the principal menace on the highway. Two disparate groups of drinking drivers were identified. One group, comprising about 90% of all persons who admit to driving after drinking, apparently do so responsibly. The other 10%, however, believe they are still safe drivers after six or more drinks, believe their legal capacity to be higher than that, and will continue to drive at levels well beyond their own conceived safe or legal levels. Despite significantly increased levels of enforcement, the general public's perception of the risk of being arrested if driving while intoxicated has generally declined. About one half the people believed they had never personally encountered a drunk driver; only one third said they had a traffic accident or a moving violation arrest in the past three years. About one half the respondents believed that countermeasures would be very effective in solving the drunk-driver problem. Moreover, 77% would support most countermeasures against the drunk driving problem (except Antabuse). Fifty-seven percent said they would be willing to pay extra taxes to support a program like that of the Alcohol Safety Action Proj. (ASAP). Although 46% of the public had heard about the ASAP program, only 14% knew it by name. Concentrated public education efforts reached only 3%-6% of the population. If two of the objectives of the ASAP (public awareness of the drinking/driving problem and enlistment of public support for effective handling of drinking drivers) are to be met, considerable education of the general public is still required. The following areas for education are considered of prime importance: the meaning of blood alcohol concentration (BAC); the effects of alcohol on the body; the distinction between social and problem drinkers, attributes of problem drinkers, and the fact that the majority of drunk driving is done by problem drinkers; the concepts of accident risk and accident probabilities; and the risks and benefits of the use of Antabuse.

by George A. Beitel; Michael C. Sharp; William D. Glauz  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-SR-9; 1974; 46p 2refs  
Prepared under subcontract to City of Kansas City, Mo. See  
also HS-802 715--HS-802 717, HS-802 719--HS-802 731.  
Availability: Reference copy only

HS-802 719

**KANSAS CITY ALCOHOL SAFETY ACTION  
PROJECT. AN ANALYSIS OF THE SPECIAL**

**ALCOHOL SAFETY PATROL. ANNUAL REPORT  
NO. 2 (PT. 3)**

The Special Alcohol Safety Patrol (SASP) of the Kansas City Alcohol Safety Action Proj. (ASAP) is an eight-man unit (seven funded by ASAP) within the Kansas City, Mo., Police Dept. Its function is to detect and arrest drunk drivers. In 1973 SASP made 1876 driving under the influence (DUI) arrests, an increase from the 1972 total of 1535. This was an average of 234.5 arrests per man-year in contrast to the traffic division's average of ten or a beat patrol's average of four. The normal SASP shift is from 8:00 P.M. to 4:00 A.M. with all court appearances during the day. One-man patrols are used exclusively. Approximately one out of four drivers stopped were subsequently arrested for DUI. Arrests peaked between 1:00 A.M. and 2:00 A.M. when the bars were closing. Arrests tended to cluster in tavern areas. Noncrash-involved persons arrested for DUI were predominately white males in their late 30's, although crash-involved arrests (by regular officers) seem to have some overrepresentation of both blacks and females. The average blood alcohol (BAC) of a noncrash-involved driver arrested by SASP was 0.178%, a significant, but small (0.005%), increase from 1972. BAC's of other persons arrested for DUI declined a comparable amount. The probability of arrest based on BAC was determined by a patrol experiment conducted by the SASP. The probability of arrest for a BAC of 0.10% or more was found to be 0.0058%. However, the probability for a BAC of 0.15% or more was estimated to be near 100% should an SASP officer be following the drunk driver. Videotaping appeared to be a statistically significant factor in increasing the conviction rates for DUI. The disposition of defendants with BAC's of 0.15% to 0.19% was most influenced by the videotaping process. The finding is unfortunately confounded by the increase of plea bargaining and by the selectiveness of videotaping as the project progressed. Subjectively, the videotaping was of benefit to both the judiciary and the police as well as being a tool for public education.

by George A. Beitel; William D. Glauz  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-AR-2-Pt-3; 1974; 36p  
Rept. for 1 Jan-31 Dec 1973. Prepared under subcontract to  
City of Kansas City, Mo. See also HS-802 715--HS-802 718,  
HS-802 720--HS-802 731.  
Availability: Reference copy only

HS-802 720

**KANSAS CITY ALCOHOL SAFETY ACTION  
PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS  
AND REFERRAL ACTIVITY. ANNUAL REPORT NO.  
2 (PT. 5)**

The judicial/referral system of the Kansas City Alcohol Safety Action Proj. (ASAP) is based on the Identification, Decision and Action (IDA) concept. The investigatory process starts when the data from the arrest trigger an alert sheet, generated by the Kansas City, Mo., Police Dept. computer. The alert sheet is used by prosecution, probation, and court records personnel to prepare for trial and conduct background investigations. Three or four days prior to the scheduled trial date, a pretrial screening report (PTSR) is generated which contains local arrest history, summary of probation and driver history checks, classification of problem drinking driver (PDD), social drinking driver (SDD) or unknown, and a referral recommendation. Final disposition and referral of the defendant is, of

course, at the judge's discretion. There were 6147 cases investigated in 1973. The PTSR identified about one third in each of the three driver-drinker categories. Ultimately, by use of the Mortimer-Filkins (M-F) questionnaire, it was determined that 58% of the cases were PDD's and 42% SDD's. For PDD's the modalities used for referral, in order of frequency, were School for Alcohol Safety - Large Group (SASL); Community Alcohol Programs (CAP's); School for Alcohol Safety - Small Group (SASS); one-to-one; and Antabuse. The random referral program was followed quite well, in total, except that the control group was virtually ignored. The success of the investigatory process helped the courts overcome a large backlog. Prosecutors used the PTSR for decisions on plea bargaining. The defendants were served quickly and referred to rehabilitative measures rather than simply receiving punitive sentences. The real measure of success of the system, recidivism, was found to be 13% for PDD's at the end of one year and 20% after two years. SDD's had only one fifth the recidivism rate of PDD's and were modeled quite well with a special case of the Weibull distribution, the simple exponential model. The investigatory costs averaged \$8.52 per disposition, a substantial reduction from the \$11.21 of 1972. The pretrial probation record check seems to be a cost-effective method of obtaining PDD classifications. Overall, the judicial/referral system functioned quite well in 1973. Two problems that should be attacked in 1974, however, are the ability of probation to handle one-to-one counseling case loads and the lack of people assigned to the random control group. The PTSR, the backbone of the system, is working well and its concept may be expanded by the court.

by William D. Glauz; James P. Foley; Michael C. Sharp  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-AR-2-Pt-5; 1974; 40p  
Rept. for 1 Jan-31 Dec 1973. Prepared under subcontract to  
City of Kansas City, Mo. See also HS-802 715--HS-802 719,  
HS-802 721--HS-802 731.  
Availability: Reference copy only

HS-802 721

**KANSAS CITY, MISSOURI ALCOHOL SAFETY  
ACTION PROJECT. ANNUAL REPORT NO. 3,  
JANUARY 1-DECEMBER 31, 1974**

The overriding goal of the Alcohol Safety Action Proj. (ASAP) is to reduce the number of alcohol-related crashes in Kansas City, Mo. In the design of the ASAP activities, the following eight objectives are basic to the successful attainment of the overall goal: increased arrest of drinking drivers (with emphasis on problem drinkers), removal of drinking drivers from the road, improved prosecution of driving under the influence (DUI) violators, identification of problem drinking drivers, rehabilitation of problem drinking drivers, public awareness of the drinking driver problem, enlistment of public support for effective handling of drinking drivers, and obtaining legislation to curb drinking drivers at the state and local levels. The first three years of ASAP have been marked by a steady decline in the numbers of fatal crashes and fatalities in Kansas City. At least 25 alcohol-related crashes may be said to have been prevented as a result of ASAP during those years. Cost/benefit is calculated on the basis of \$234,960 as the cost of one fatal crash. There were 2080 DUI arrests made in 1974, many in areas containing taverns and at the hours of tavern closings. All prosecutors now use the pretrial screening report in making sentencing recommendations to the court. There was a tre-

february 28, 1978

HS-802 724

mendous increase in plea bargaining. The ending of the probation counseling activity in May allowed probation officers to concentrate on investigation, referral, and monitoring. There were 4577 referrals to rehabilitation agencies. The School for Alcohol Safety for large groups of social drinkers seems to have been successful. Data entry problems of earlier ASAP years were resolved, and the backlog cleared up. Public relations for ASAP were handled via 18 television spots, 27 radio spots, 36 speeches, 36 news clips, and the distribution of 5400 pamphlets and 566 newsletters.

Kansas City Alcohol Safety Action Proj., 414 East 12th St.,  
Kansas City, Mo. 64106  
Contract DOT-HS-077-1-100  
Rept. No. AR-3; 1975; 44p 6refs  
See also HS-802 715--HS-802 720, HS-802 722--HS-802 731.  
Availability: Reference copy only

HS-802 722

#### **KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY**

A total of 506 randomly selected persons completed the interview during the Sep 1974 survey of attitudes toward alcohol and traffic safety. It was found that the public is becoming more knowledgeable about the role of alcohol in traffic accidents. Yet, the exact meaning of blood alcohol concentration (BAC) and what relationship BAC levels have to legal limits and accident involvement is not well understood. For the first time in four years a majority recognized the problem drinker as the drinker type responsible for alcohol-related traffic fatalities. The Alcohol Safety Action Proj. (ASAP) program was still found to be unknown to the majority of people even though it has been active in Kansas City, Mo., for three years. The public demonstrated a definite ordering of the presumed effectiveness of drunk driver countermeasures. The presumed effectiveness was highest for more severe penalties, better rehabilitation, and more enforcement. Antabuse still remains an unfavored countermeasure. In general, the public is unwilling to support ASAP monetarily. Perhaps one reason why the needed support has not been forthcoming is that the drunk driving problem may not be real to most people. Only one third of the respondents admitted to any personal involvement with a drunk driver. The perception of the risk of arrest when driving under the influence remains, and in fact is, low. However, some progress has been made in educating the public as evidenced by the increasing proportion that claim to have refused to drive after drinking as well as driving when they felt they should not. The analysis of special target groups leads to the fact that there needs to be an education effort targeted to the drinker-driver which is different from that for the general public. The analysis of socioeconomic variations shows that the drinking-driving problem is not unique to any socioeconomic status, but there are differences between socioeconomic groups in knowledge of and reaction to the drunk driving problem. The following actions are recommended: a campaign aimed at the general public primarily to produce grass roots support for ASAP, special educational efforts targeted for drinker-drivers and/or moderate to heavy drinkers, continued efforts to educate both the public and target groups about differences between problem and social drink-

ers, support for and confidence in Antabuse as a rehabilitation measure, and more publicity on the success of ASAP.

by James P. Foley; William D. Glauz; Michael C. Sharp  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-SR-10; 1975; 90p  
Prepared under subcontract to City of Kansas City, Mo. See  
also HS-802 715--HS-802 721, HS-802 723--HS-802 731.  
Availability: Reference copy only

HS-802 723

#### **KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY**

Most of the results coincided with those of the previous three annual surveys. Drinking increased in frequency and amount as the night wore on. No significant day of the week effects were found except that the proportion of drivers who had been drinking on weekends was greater than it was on weekdays. An attempt to profile the problem drinking driver was made with not very useful results. An analysis of the youthful driver showed that teenagers were rarely drinking, never drunk, and disproportionate among those claiming to be non-drinkers. However, those in their 20's do drink and drive and claim to be fairly heavy consumers of alcohol (although they were underrepresented among drunk drivers). It is believed that any classification of drinker type is valid only in the respondent's frame of reference and it is risky, at best, to make comparisons of groups based on such classifications. A new technique for collection of roadside breath samples was tried with great success. Refusals dropped threefold and data collection was faster and easier. The following actions are recommended: arrangement of future surveys to use a minisurvey technique for data collecting (loss in detailed information more than offset by decrease in refusal rate and increase in number of drivers interviewed), targeting of public information campaigns to the drunk driver and youths in their 20's, and education of the public as to what moderate drinking habits are.

by James P. Foley; William D. Glauz  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-SR-11; 1975; 83p  
Prepared under subcontract to City of Kansas City, Mo. See  
also HS-802 715--HS-802 722, HS-802 724--HS-802 731.  
Availability: Reference copy only

HS-802 724

#### **KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)**

The Special Alcohol Safety Patrol (SASP) of the Kansas City Alcohol Safety Action Proj. (ASAP) is comprised of a seven-man unit within the Kansas City, Mo., Police Dept. whose objective is to detect and arrest drunk drivers. One-man patrol cars operate between 8:00 P.M. and 4:00 A.M. Monday through Saturday. Arrests were found to peak around 1:00 A.M., coinciding with the closing of the bars. Over 80% of the 1974 alcohol-related fatal crashes occurred during SASP duty hours, indicating the patrol is operating at the appropriate time

to try to deter such crashes. Arrests continued to predominate in areas with high concentration of bars (both SASP and regular patrol arrests), but SASP arrests were more evenly distributed throughout the city than in past years. Less than 1% of those arrested by the SASP had a blood alcohol concentration (BAC) of less than 0.10%, compared with 5% of those arrested by the regular patrol being below the legal limit. Also, the SASP had about one half the breath test refusals of the regular patrol. There was no significant difference in the age or sex of those arrested by the SASP and regular patrol. The individual officers of the SASP did vary in performance. The most productive officer had almost 100 more arrests during the year than the least productive. Also, the officers with the most arrests had the fewest refusals of the breath test. Overall, the section improved its performance for the third year in a row. The most significant improvement was the increase in arrests per total hour; this indicates improved performance in court and in other nonpatrol activities as well as more arrests during patrol hours. The following actions are recommended: careful monitoring of manpower assignments by day of week for the SASP with changes made if deemed necessary; provision for exchange of ideas and techniques among the SASP members; encouragement of the practice of cooperative arrests; continuance by the SASP members in participation in public information efforts; and institution and evaluation of an experiment to measure the effect of concentrating on the bars to prevent drunk drivers from traveling excessive distances.

by James P. Foley; William D. Glauz  
 City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
 Blvd., Kansas City, Mo. 64110  
 Contract DOT-HS-077-1-100  
 Rept. No. MRI-AR-3-Pt-3; 1975; 50p 2refs  
 Rept. for 1 Jan-31 Dec 1974. Prepared under subcontract to  
 City of Kansas City, Mo. See also HS-802 715--HS-802 723,  
 HS-802 725--HS-802 731.

Availability: Reference copy only

**APPENDIX H TABLES. JANUARY - DECEMBER,  
 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY  
 ACTION PROJECT. ANNUAL REPORT]**

Statistics on the following aspects of the Kansas City, Mo., Alcohol Safety Action Proj. are provided: fatal multivehicle crashes excluding pedestrian crashes, fatal single vehicle crashes excluding pedestrian crashes, fatal pedestrian crashes, total fatal crashes, injuries in pedestrian crashes, and injuries in total crashes. In addition, data are provided for overall crash data, blood alcohol concentration (BAC) for drivers killed, BAC data for drivers arrested for alcohol-related (A/R) offenses, enforcement (financial and personnel), enforcement (ASAP patrol activity by time of day), and enforcement (regular patrol activity by time of day), judicial (financial data). Other statistics deal with judicial operations (disposition of A/R traffic arrests), judicial (background investigation activity), rehabilitation (financial and personnel), rehabilitation (program status report), public information and education (activity summary), and total project (financial and personnel). Data are presented separately for the quarters of 1974.

Kansas City Alcohol Safety Action Proj., 414 East 12th St.,  
 Kansas City, Mo. 64106  
 Contract DOT-HS-077-1-100  
 Rept. No. AR-3-App-H; 1975?; 93p  
 Appended to HS-802 721. See also HS-802 715--HS-802 720,  
 HS-802 722--HS-802 724, HS-802 726--HS-802 731.  
 Availability: Reference copy only

**KANSAS CITY ALCOHOL SAFETY ACTION  
 PROJECT. AN ANALYSIS OF PROJECT IMPACT ON  
 ULTIMATE PERFORMANCE MEASURES. ANNUAL  
 REPORT NO. 3 (PT. 1)**

The Kansas City, Mo., Alcohol Safety Action Proj. (ASAP) has been highly successful in meeting its objective to reduce the number of alcohol-related (A/R) traffic crashes. A/R fatal crashes during the three years 1972-1974 were 25 fewer than projected, even after accounting for the general, energy-crisis-related decline in all fatal crashes in 1974. This finding was statistically significant, as was a calculated reduction of 699 nighttime injury crashes, half of which can be attributed to reduced drunk driving. Significant reductions were observed in nighttime drinking and driving in Kansas City, particularly at the high levels of intoxication commonly found in crash-involved drinking drivers. The incidence of the latter behavior dropped to about half of its previous level. A small, but important, decrease in average level of intoxication among arrested drivers has also been documented. Public knowledge and awareness were found to have increased, even though the public's admissions of drinking-driving actions and related measures of behavioral changes deteriorated. Overall, the benefits of the \$2.1 million program through accident reductions were determined to be \$9.8 million, a return of 4.7 to 1. Further benefits include increased city income in fines, increased attorney incomes, decreased accident-caused property damage, and potentially great personal gains to the many who have been helped through ASAP. The major recommendations concerning needs for special enforcement emphasis are as follows: increase Friday and Saturday night patrolling; initiate patrolling on Sunday nights; pay particular attention to young, speeding drivers, particularly if they have been drinking; collect life-change data; and step up an intensive public information campaign.

by William D. Glauz; James P. Foley; Michael C. Sharp  
 City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
 Blvd., Kansas City, Mo. 64110  
 Contract DOT-HS-077-1-100  
 Rept. No. MRI-AR-3-Pt-1; 1975; 78p 3refs  
 Rept. for 1 Jan-31 Dec 1974. Prepared under subcontract to  
 City of Kansas City, Mo. See also HS-802 715--HS-802 725,  
 HS-802 727--HS-802 731.

Availability: Reference copy only

**KANSAS CITY ALCOHOL SAFETY ACTION  
 PROJECT. PUBLIC INFORMATION AND  
 EDUCATION. ANNUAL REPORT NO. 3 (PT. 7)**

Of the Kansas City, Mo., Alcohol Safety Action Proj. (ASAP) objectives, the following three were specifically related to public information and education: develop public awareness of the drinking driver problem, enlist public support for the effective handling of drinking drivers, and obtain legislation to curb drinking drivers at the state and local level. Analysis of all proposed measures of accomplishment from 1972 through 1974 showed positive indications of progress. Public knowledge of the drinking and driving problem definitely increased, although most people could not name the program, its sponsor, or specific facts about the program. Evidence of public support increased through 1973, but dropped markedly in 1974. The majority of the population does not appreciate the personal dangers of drunk driving. Major legislation (lowering

february 28, 1978

HS-802 729

the presumptive limit) was passed in 1972. A per se law was passed recently, but not in the form favorable to ASAP. Media support has been generally good, although not as active and innovative as desired. The Speaker's Bureau was active, and probably a major factor in the development of several small ASAP-like programs throughout Missouri. However, strong support of the Kansas City ASAP, proven to have been successful in its mission, has not been experienced at the state level. A revitalization of the public information and education program is recommended, with well defined objectives, targets, and methodologies. Specific concerns are the generation of more public support, enlistment of the aid of close acquaintances of drunk drivers, informing state and local elected officials, and (especially) means of reaching the young drinking driver.

by William D. Glauz  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-AR-3-Pt-7; 1975; 120p 2refs  
Rept. for 1 Jan-31 Dec 1974. Prepared under subcontract to  
City of Kansas City, Mo. See also HS-802 715--HS-802 726,  
HS-802 728--HS-802 731.  
Availability: Reference copy only

HS-802 728

#### KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY

A survey was conducted in May 1975 to test the response to the Kansas City, Mo., Alcohol Safety Action Proj. (ASAP) efforts in public education and information. The program emphasized intervention on behalf of friends and relatives who had had too much to drink. The survey suffered from a poor acceptance rate, and yielded responses from a group with higher education and income, and with fewer young adults, than the population at large. Nevertheless, this group of respondents displayed concern for the problem of drunk driving. Most would apparently take action to prevent a drunk friend from driving, and would plan parties to minimize the chances of persons becoming too drunk. However, their concept of drunkenness is based more on ability to walk and talk than on alcohol consumption, indicating their actions would be too late and too little. A minority would not take any action and would encourage further intoxication of their guests. Most people are not aware of the current campaign. Those that are aware became so through local TV spots rather than network (nationwide) advertisements. However, stated awareness was not related to attitudes or to self-predicted actions with drunk friends or relatives, so that no impact could be discerned. People who knew about ASAP were more likely to know of an arrested friend or relative, and thought they were more likely to be arrested than did others. They were also more likely to have seen or heard drinking/driving ads, but were no more knowledgeable about the subject. Persons most concerned about drunk driving were females, nondrivers, those not accustomed to situations involving drinking, and those deeply concerned about other societal problems. Finally, responses from residents of Kansas City were indistinguishable from those of residents of the nearby suburbs. Recommendations include continued education efforts, particularly at the local level. An emphasis area is distinguishing the concept of drunk as it relates to driving impairment from the physically incapacitating condition. Persons who intentionally get their

guests intoxicated are singled out as a potential target group. Revisions to the questionnaire are suggested.

by William D. Glauz; Rosemary Moran  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-SR-12; 1975; 53p  
Prepared under subcontract to City of Kansas City, Mo. See  
also HS-802 715--HS-802 727, HS-802 729--HS-802 731.  
Availability: Reference copy only

HS-802 729

#### KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT NO. 3 (PT. 6)

Rehabilitation efforts of the Kansas City, Mo., Alcohol Safety Action Proj. (ASAP) consisted of three ASAP-funded modalities and one modality funded by the National Inst. on Alcohol Abuse and Alcoholism (NIAAA). The School for Alcohol Safety - Large Group (SASL) was designed for social drinking drivers (SDD's) and was utilized heavily, both for SDD's and problem drinking drivers (PDD's). A companion modality, School for Alcohol Safety - Small Group (SASS), was conceived for PDD's. Chemotherapy (Antabuse) was used with PDD's, often in conjunction with one of the counseling modalities. Community Alcohol Programs (CAP's), the NIAAA agency, utilized intake interviews, individual preferential counseling, and then referral to one of 11 community agencies for longer term PDD counseling. Completion rates for SASL and SASS (roughly, 90% and 80%, respectively) were fairly high. The rates for CAP and chemotherapy were lower, but precise figures are unavailable at this time. Probation revocations increased markedly, from fewer than 100/year in 1972 and 1973 to over 300 in 1974, reflecting more concerted action by the probation department and the courts. Relative effectiveness of the treatment programs was measured in terms of recidivism (rearrest for DUI (driving under the influence)). For PDD's, CAP was the most effective; one-to-one counseling, a modality discontinued early in 1974, was the least effective. SASL was relatively effective for SDD's but not for the other groups. Chemotherapy was fairly effective. A rather consistent trend among all modalities was that recidivism rates were lowest for persons convicted most recently, even after correcting for time of exposure to potential arrest. Cost data for 1974 were similar to earlier data, with CAP being most expensive and SASL least expensive. Chemotherapy has become more economical as the size of the program has increased and case loads kept more active. Profile data show that persons assigned to CAP and chemotherapy had higher BAC's (blood alcohol concentration), more previous convictions, and higher Mortimer-Filkins test scores than those assigned to SASL. Recidivism was more closely related to prior conviction than to BAC or test score. The major recommendations are that SASS be discontinued (it has been), and that more in-depth analyses, using more statistical techniques, are required to

HS-802 730

HSL 78-02

better determine the relative effectiveness of the treatment modalities in minimizing recidivism for different driver types.

by James P. Foley; William D. Glauz  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-AR-3-Pt-6; 1975; 76p  
Rept. for 1 Jan-31 Dec 1974. Prepared under subcontract to  
City of Kansas City, Mo. See also HS-802 715--HS-802 728,  
HS-802 730, and HS-802 731.  
Availability: Reference copy only

HS-802 730

**KANSAS CITY ALCOHOL SAFETY ACTION  
PROJECT. PROFILE STUDIES OF DRIVERS  
IMPAIRED BY ALCOHOL. ANNUAL REPORT NO. 3  
(PT. 8)**

Profile studies were made of drivers impaired by alcohol as a part of the Kansas City, Mo., Alcohol Safety Action Proj. (ASAP). One very obvious finding was that it is rather naive to attempt to describe a typical drunk driver in terms of demographic characteristics. Therefore, rather broad distributions of characteristics must be examined. Basically, the people arrested and subjected to various actions and countermeasures were, indeed, people with drinking-driving problems. The distributions of profile characteristics of persons convicted did not differ much from the distributions of those arrested. There was a tendency for persons with more severe drinking problems, and of lower socioeconomic status, to more often receive a conviction on the original DUI (driving under the influence) charge, as opposed to plea bargaining to a lesser charge, and thereby to more likely incur administrative licensing action. Of those convicted, the persons most likely to be referred to ASAP and to the intensive counseling or chemotherapy treatment modalities were those with more severe drinking problems. They tended to be somewhat older than the average of all persons arrested, and to have a higher initial blood alcohol content (BAC), lower income, higher Mortimer-Filkins psychological test score (indicating more severe problems), more prior alcohol-related (A/R) convictions, and they were more likely to be nonwhite. In contradistinction, persons who received only a fine or who were referred to an educational program (SASL, School for Alcohol Safety - Large Group) tended to have the opposite characteristics. Recidivists differed significantly from nonrecidivists in every measure examined. They had a tendency toward the same characteristics as those convicted persons referred to ASAP and to the intensive counseling or chemotherapy treatment modalities. It was found that young (under 30) drivers and drivers with above average incomes were dominant as types of people who have been underrepresented as ASAP clients. This can be explained possibly by the fact that younger drinking drivers are known to become impaired at lower BAC's than older drivers, at levels below the present presumptive limit in Missouri (and in most states); and that higher income drivers are hypothesized to do less driving, while drunk, in those

areas where patrol activity is heaviest, thus being less exposed to the probability of arrest.

by William D. Glauz  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-AR-3-Pt-8; 1976; 80p 4refs  
Rept. for 1 Jan-31 Dec 1974. Prepared under subcontract to  
City of Kansas City, Mo. See also HS-802 715--HS-802 729,  
HS-802 731.  
Availability: Reference copy only

HS-802 731

**KANSAS CITY ALCOHOL SAFETY ACTION  
PROJECT. 1975 ROADSIDE SURVEY**

A total of 1059 drivers provided breath samples and answered questions in the Oct 1975 survey. Overall, 26.9% of the drivers had been drinking, as indicated by breath tests, and 4.9% would have been presumed intoxicated under the state laws of Missouri (blood alcohol content (BAC) of 0.10% or greater). These percentages are below those obtained prior to ASAP (29.2% and 5.5%), but higher than in 1974 (26.5% and 4.2%). The percentage of very high BAC's (0.15% or more) remained at the 1% level obtained the previous two years, which was significantly less than the 2% pre-ASAP level. As in previous surveys, drinking behavior increased significantly later in the evening, and to some extent depended on the day of the week. Data (1975 and four previous years) adjusted to account for differences in sample sizes by time of day and day of week show a recent regression toward pre-ASAP drinking and driving patterns. They also show an increase in moderate drinking levels (BAC of 0.05% to 0.09%), to nearly 11% (adjusted) of the nighttime driving population, the highest percentage yet observed. Related to this apparent recent increase in drinking and driving is the 35% to 40% increase over the 1972-1973 figures in the percentage of nighttime drivers coming from bars and restaurants. A startling increase in drinking and driving among teenagers was found. Not only are teenagers accounting for an ever increasing fraction of the nighttime drivers (14% in 1975), but one out of five of them had been drinking. The essentially unpublicized survey was known to fewer than 17% of the drivers, less than half the percentage usually observed. Moreover, the public's awareness of a drinking/driving program in Kansas City is steadily deteriorating from its 1972-1973 level; only 38% said they had heard about such a program, and half of that group could remember nothing about what they had heard.

by William D. Glauz; Michael C. Sharp  
City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker  
Blvd., Kansas City, Mo. 64110  
Contract DOT-HS-077-1-100  
Rept. No. MRI-SR-13; 1976; 68p  
Prepared under subcontract to City of Kansas City, Mo. See  
also HS-802 715--HS-802 730.  
Availability: Reference copy only

HS-810 308

**LOSS PREVENTION: THE CONSUMER'S AND THE  
INDUSTRY'S RESPONSIBILITIES**

The insurance industry is urged to continue and increase its use of underwriting as a promotion of vehicle safety design. State insurance departments should pay more attention to rat-

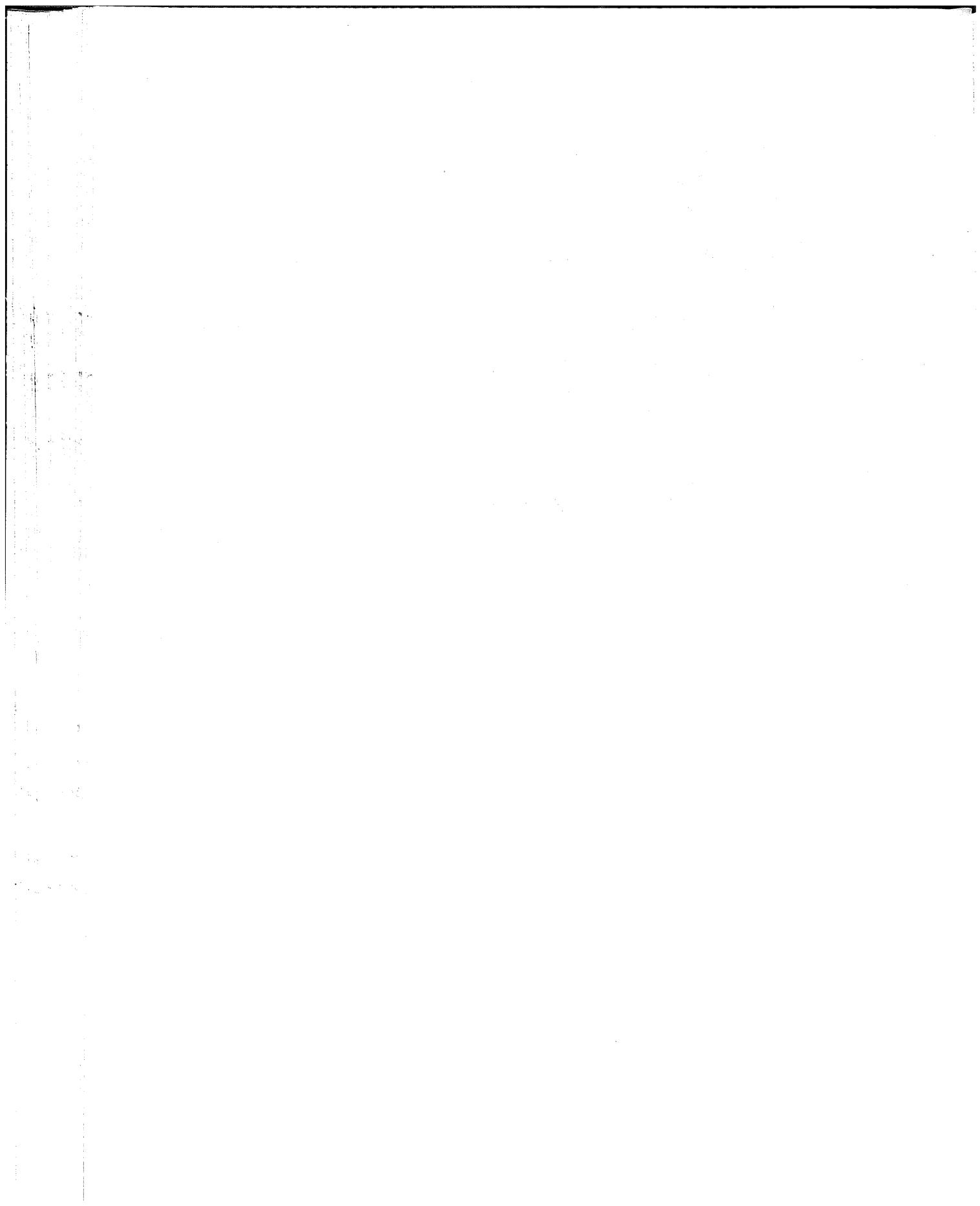
february 28, 1978

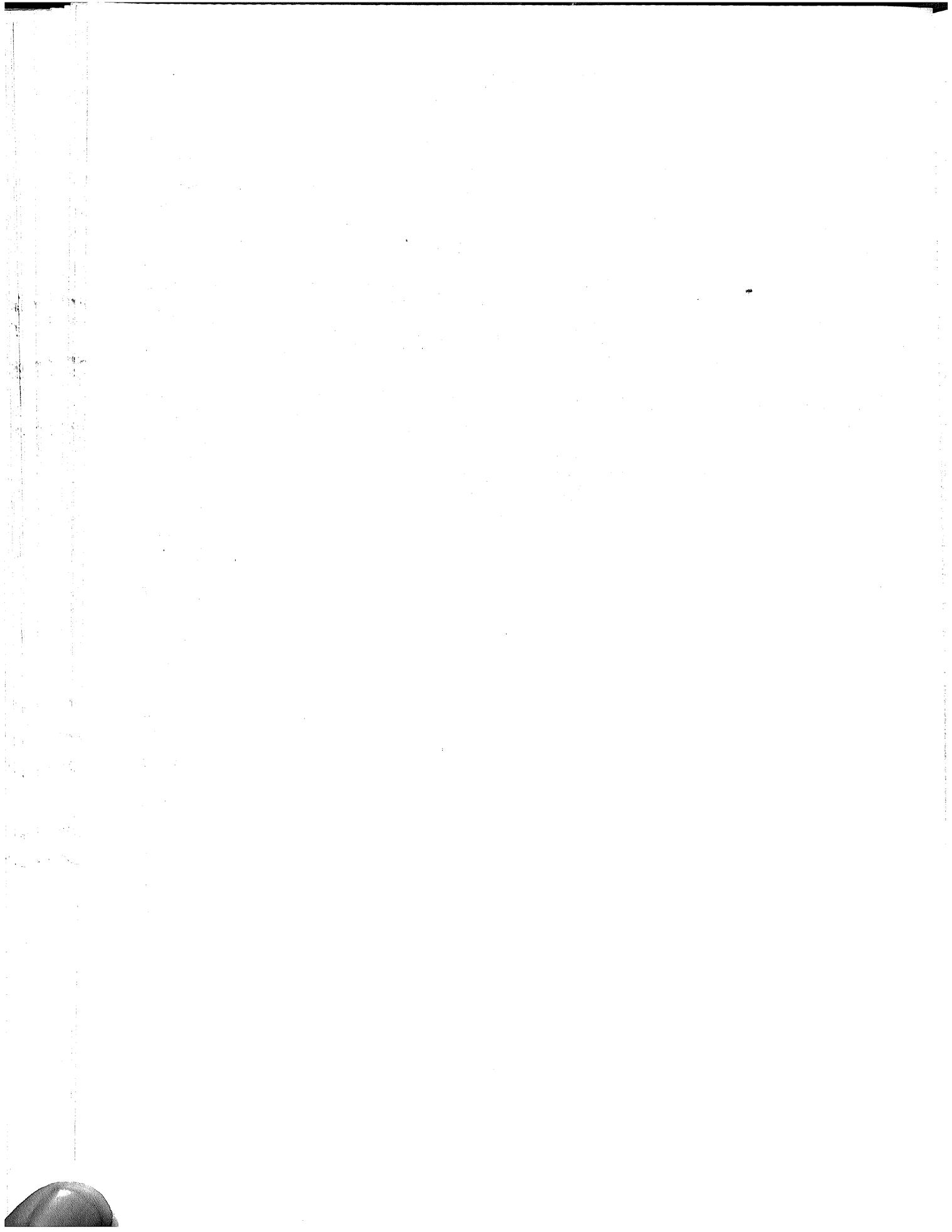
HS-810 308

ing and disclosure systems affecting vehicle design. A task force should be established to consider rating of cars and light trucks in terms of their comparative crashworthiness and damageability. Insurance companies should offer discounts for cars equipped with passive restraints, in keeping with their public policy that the savings from reduced death and injury with passive restraints will be passed on to policyholders. When cars equipped with passive restraints begin to appear on the highway in the 1980's, insurance commissions in no-fault states should begin to set rate differentials immediately without waiting for most cars to have such passive designs. Legislation limiting manufacturers' liability shows a bias against the consumers' right to recover damages and diminishes the deterrent effect against defective manufacturing that liability rights have. Proposed state legislation to deny liability if the product meets government performance standards or if the product is as good as the state of the art is also worrisome. The task force of the Dept. of Commerce on product liability found no support of the crisis cries of the insurance industry or the demand for drastic overhaul of the common law of product liability. Insurance commissioners should gather data on the subject to combat misleading assertions.

by Joan Claybrook  
National Hwy. Traffic Safety Administration  
Rept. No. NAD-41; 1977; 7p  
Presented before the National Assoc. of Insurance  
Commissioners, Madison, Wis., 10 Oct 1977.  
Availability: Reference copy only

## **INDEX to ABSTRACTS**





## KWOC Title Index

### **ABSORBING**

THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY  
HS-021 578

### **ACCEPTANCE**

DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT  
HS-021 491

### **ACCURACY**

TESTING OF VEHICLE SPEEDOMETERS AND ODOMETERS FOR ACCURACY. FINAL REPORT  
HS-802 713

### **ACTION**

APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT]  
HS-802 725

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3)  
HS-802 717

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3)  
HS-802 719

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)  
HS-802 720

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)  
HS-802 724

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)  
HS-802 726

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT NO. 3 (PT. 6)  
HS-802 729

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY  
HS-802 728

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY ALCOHOL. ANNUAL REPORT NO. 3 (PT. 8)  
HS-802 730

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7)  
HS-802 727

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY  
HS-802 716

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY  
HS-802 718

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY  
HS-802 722

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY  
HS-802 723

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY  
HS-802 731

KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 1, JANUARY 1-DECEMBER 31, 1972  
HS-802 715

KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 3, JANUARY 1-DECEMBER 31, 1974  
HS-802 721

THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"  
HS-021 596

### **ACTIVITY**

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)  
HS-802 720

### **ADAMS**

SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM  
HS-021 516

### **ADEQUACY**

THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND APPROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS  
HS-802 302

### **ADMINISTRATORS**

A DEGREE PROGRAM FOR EMS ADMINISTRATORS - A UNIQUE APPROACH  
HS-021 574

FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.  
HS-021 540

### **AEROSOLS**

THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY  
HS-021 526

### **AIR**

ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]  
HS-021 584

		HSL 78-02
USE OF SODIUM AZIDE FOR AIR CUSHION INFLATOR	HS-021 484	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7)
<b>AIRBAGS</b>		HS-802 727
STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?	HS-021 536	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY
		HS-802 716
<b>ALCOHOL</b>		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY
A PROFILE OF FATAL ACCIDENTS INVOLVING ALCOHOL	HS-021 586	HS-802 718
ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS	HS-021 590	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY
		HS-802 722
ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT	HS-021 470	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY
		HS-802 723
APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT]	HS-802 725	KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 1, JANUARY 1-DECEMBER 31, 1972
		HS-802 715
BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587	KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 3, JANUARY 1-DECEMBER 31, 1974
		HS-802 721
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3)	HS-802 717	THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING-RELATED SKILLS PERFORMANCE
		HS-021 588
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3)	HS-802 719	<b>ALICE</b>
		KANSAS CITY IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC
		HS-021 561
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-802 720	<b>ALLEGED</b>
		KONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S
		HS-021 541
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)	HS-802 724	<b>ALTERNATIVES</b>
		FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES
		HS-020 978
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-802 726	<b>ALUMINUM</b>
		ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION
		HS-021 562
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF FIRST TELEPHONE SURVEY	HS-802 728	<b>AMERICAN</b>
		AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CON-

february 28, 1978

ERENCE, VANCOUVER, BRITISH COLUMBIA  
[CANADA], SEPTEMBER 15-17, 1977  
HS-021 568

**ANALYSES**

NON-LINEAR MODEL FORMULATION FOR THE  
STATIC AND DYNAMIC ANALYSES OF FRONT  
SUSPENSIONS  
HS-021 515

**APPROPRIATENESS**

THE RESULTS OF THE NHTSA SURVEY: FOR AN  
EVALUATION OF THE ADEQUACY AND AP-  
PROPRIATENESS OF THE NHTSA UNIFORM  
HIGHWAY SAFETY STANDARDS  
HS-802 302

**ARISING**

CONSUMER SATISFACTION WITH THE EXTENT OF  
GOVERNMENTAL INDUCED VEHICLE SAFETY  
DESIGN AS INDICATED BY JUDGES AND JURORS IN  
TORT LITIGATION DECISIONS ARISING OUT OF AL-  
LEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE  
1980'S  
HS-021 541

**ARTHRITIS**

DASHBOARD AND BUMPER KNEE - WILL  
ARTHRITIS DEVELOP?  
HS-021 592

**ASPIRATION**

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 11, 3  
MAY 1976 TO 6 JUNE 1976  
HS-802 671

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 12, 7  
JUNE 1976 TO 6 JULY 1976  
HS-802 672

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 13, 5  
JULY 1976 TO 8 AUGUST 1976  
HS-802 673

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AU-  
GUST 1976 TO 12 SEPTEMBER 1976  
HS-802 674

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 15, 13  
SEPTEMBER 1976 TO 10 OCTOBER 1976  
HS-802 675

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 16, 11  
OCTOBER 1976 TO 7 NOVEMBER 1976  
HS-802 676

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 17, 8  
NOVEMBER 1976 TO 5 DECEMBER 1976  
HS-802 677

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 18, 6  
DECEMBER 1976 TO 9 JANUARY 1977  
HS-802 678

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 19, 10  
JANUARY 1977 TO 13 FEBRUARY 1977  
HS-802 679

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 20, 14  
FEBRUARY 1977 TO 13 MARCH 1977  
HS-802 680

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 21, 14  
MARCH 1977 TO 10 APRIL 1977  
HS-802 681

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 22, 11  
APRIL 1977 TO 1 MAY 1977  
HS-802 682

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 23, 2  
MAY 1977 TO 5 JUNE 1977  
HS-802 683

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 24, 6  
JUNE 1977 TO 10 JULY 1977  
HS-802 684

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 25, 11  
JULY 1977 TO 14 AUGUST 1977  
HS-802 685

**ASSEMBLY**

EVALUATION OF A HUB ASSEMBLY

HS-021 480

**ASSESSMENT**

ASSESSMENT OF THE APPLICATION OF AUTO-  
MATIC VEHICLE IDENTIFICATION TECHNOLOGY  
TO TRAFFIC MANAGEMENT. APPENDIX B: EVALU-  
ATION OF POTENTIAL APPLICATIONS OF AUTO-  
MATIC VEHICLE IDENTIFICATION TO TRAFFIC  
MANAGEMENT. FINAL REPORT  
HS-021 605

ASSESSMENT OF THE APPLICATION OF AUTO-  
MATIC VEHICLE IDENTIFICATION TECHNOLOGY  
TO TRAFFIC MANAGEMENT. APPENDIX C: EVALU-  
ATION OF POTENTIAL APPLICATIONS OF AUTO-  
MATIC VEHICLE MONITORING TO TRAFFIC  
MANAGEMENT. FINAL REPORT  
HS-021 606

**ASSOCIATED**

INVESTIGATION OF INJURY MECHANISMS AS-  
SOCIATED WITH FULLY RESTRAINED PASSENGER

		HSL 78-02
VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]	HS-021 579	
<b>ASSOCIATION</b>		
AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CONFERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977	HS-021 568	
FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.	HS-021 540	
<b>ATTITUDE</b>		
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 716	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 718	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 722	
<b>ATTITUDES</b>		
PUBLIC ATTITUDES ON RESTRAINT SYSTEMS: AN ANNOTATED BIBLIOGRAPHY	HS-021 493	
<b>AUTO</b>		
WHAT COMES NEXT IN AUTO SAFETY?	HS-021 534	
<b>AUTOCATALYSTS</b>		
IMMUNOLOGICAL STUDIES ON PLATINUM COMPLEXES AND THEIR POSSIBLE RELEVANCE TO AUTOCATALYSTS	HS-021 524	
<b>AUTOMATIC</b>		
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605	
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 606	
<b>AUTOMOBILE</b>		
AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS	HS-021 563	
DYNAMIC MODELS OF THE U.S. AUTOMOBILE FLEET. FINAL REPORT	HS-021 489	
		ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE HS-021 550
		STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 1. DESCRIPTION. FINAL REPORT HS-021 487
		STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 2. ANALYSIS. FINAL REPORT HS-021 488
<b>AUTOMOBILES</b>		
BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES	HS-021 559	
<b>AUTOS</b>		
ELASTOMERIC USE IN 1978 AUTOS	HS-021 501	
<b>AVAILABILITY</b>		
ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT	HS-021 470	
<b>AWARENESS</b>		
CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE	HS-021 557	
<b>AZIDE</b>		
USE OF SODIUM AZIDE FOR AIR CUSHION INFLATOR	HS-021 484	
<b>BALANCE</b>		
ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT	HS-021 566	
<b>BALANCING</b>		
BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES	HS-021 559	
<b>BARBITURATES</b>		
BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587	
<b>BARIUM</b>		
SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS	HS-021 528	
<b>BARRIER</b>		
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER	HS-802 696	
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER	HS-802 697	

february 28, 1978

<b>BASE</b>		
ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]	HS-021 584	
<b>BCA</b>		
SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS	HS-021 528	
<b>BEAMS</b>		
FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472	
THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY	HS-021 578	
<b>BEHAVIOR</b>		
TRAVEL BEHAVIOR UNDER INCREASES IN GASOLINE PRICES	HS-021 474	
YOUNG PEDESTRIAN BEHAVIOR	HS-021 473	
<b>BELT</b>		
PASSIVE SEAT BELT STUDY. MONTHLY PROGRESS REPORT NO. 2	HS-802 687	
<b>BELTS</b>		
STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?	HS-021 536	
<b>BENEFITS</b>		
STUDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS	HS-021 490	
THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES	HS-021 565	
<b>BEST</b>		
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS	HS-021 529	
<b>BEVERAGE</b>		
ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT	HS-021 470	
<b>BIBLIOGRAPHY</b>		
A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT	HS-021 492	
PUBLIC ATTITUDES ON RESTRAINT SYSTEMS: AN ANNOTATED BIBLIOGRAPHY	HS-021 493	
<b>BODY</b>		
VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION	HS-021 521	
<b>BRAKE</b>		
ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]	HS-021 584	
MINICARS RSV BRAKE SYSTEM	HS-021 535	
<b>BRAKING</b>		
THE SAFEST WAY TO CRASH...DON'T. AN EXAMINATION OF EMERGENCY BRAKING TECHNIQUES	HS-021 481	
<b>BRITISH</b>		
AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CONFERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977	HS-021 568	
BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587	
DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]	HS-021 572	
<b>BROTHERHOOD</b>		
THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553	
<b>BUMPER</b>		
DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?	HS-021 592	
TOYOTA'S LIGHT-WEIGHT NO-DAMAGE ELASTOMER BUMPER	HS-021 544	
<b>BUMPERS</b>		
THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY	HS-021 578	
<b>BUS</b>		
INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS	HS-021 556	
MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES	HS-802 303	
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-		

HSL 78-02

SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977

HS-802 689

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977

HS-802 690

**BUSES**

GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE

HS-021 583

**CALCULATING**

A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS

HS-021 532

**CALENDAR**

HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976

HS-021 496

**CALIBRATION**

OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS

HS-021 530

**CALIBRATIONS**

A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS

HS-021 532

**CALIFORNIA**

CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES

HS-021 525

**CALMAN**

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED

HS-802 686

**CANADA**

AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CONFERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977

HS-021 568

DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]

HS-021 572

ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]

HS-021 584

INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]

HS-021 579

ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS

HS-021 591

ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN CANADA

HS-021 589

THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE

HS-021 599

**CANDIDATES**

EVALUATION OF SULFATE TRAPPING CANDIDATES-RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS

HS-021 523

**CAR**

ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION

HS-021 562

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED

HS-802 686

MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?

HS-020 722

THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY)

HS-021 551

THE TARGET CAR PROGRAM FOR 1977

HS-021 545

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 691

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 692

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 693

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 694

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 695

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER

HS-802 696

february 28, 1978

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 7. TEST TYPE: CAR-TO-BARRIER

HS-802 697

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 698

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 699

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 700

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 701

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 702

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 703

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 704

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON

HS-802 705

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT

HS-802 706

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 707

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT

HS-802 708

#### CARBURETOR

TRANSIENT RESPONSE OF A CARBURETOR ENGINE

HS-021 467

#### CAROLINA

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINIS-  
TRATION, TRUCK AND BUS SAFETY SUBCOMMIT-  
TEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-  
SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER  
19, 1977

HS-802 689

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINIS-  
TRATION, TRUCK AND BUS SAFETY SUBCOMMIT-  
TEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-

SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER  
20, 1977

HS-802 690

#### CARS

CONVINCING THE PUBLIC TO BUY THE MORE  
FUEL-EFFICIENT CARS: AN URGENT NATIONAL  
NEED. REPORT TO THE CONGRESS

HS-021 471

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 11, 3  
MAY 1976 TO 6 JUNE 1976

HS-802 671

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 12, 7  
JUNE 1976 TO 6 JULY 1976

HS-802 672

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 13, 5  
JULY 1976 TO 8 AUGUST 1976

HS-802 673

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AU-  
GUST 1976 TO 12 SEPTEMBER 1976

HS-802 674

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 15, 13  
SEPTEMBER 1976 TO 10 OCTOBER 1976

HS-802 675

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 16, 11  
OCTOBER 1976 TO 7 NOVEMBER 1976

HS-802 676

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 17, 8  
NOVEMBER 1976 TO 5 DECEMBER 1976

HS-802 677

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 18, 6  
DECEMBER 1976 TO 9 JANUARY 1977

HS-802 678

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 19, 10  
JANUARY 1977 TO 13 FEBRUARY 1977

HS-802 679

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 20, 14  
FEBRUARY 1977 TO 13 MARCH 1977

HS-802 680

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 21, 14  
MARCH 1977 TO 10 APRIL 1977

HS-802 681

HSL 78-02

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 22, 11 APRIL 1977 TO 1 MAY 1977	HS-802 682	CHARACTERIZATION	CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES	HS-021 525
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 23, 2 MAY 1977 TO 5 JUNE 1977	HS-802 683	CHARGE	EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION	HS-021 468
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 24, 6 JUNE 1977 TO 10 JULY 1977	HS-802 684	CHARGED	FEES STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES	HS-020 978
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 25, 11 JULY 1977 TO 14 AUGUST 1977	HS-802 685	CHECK	HABIT CHECK OF SEEING AND RESPONDING IN DRIVING	HS-021 477
EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567	CHEMICAL	THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY	HS-021 526
<b>CASUALTIES</b>				
ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT	HS-021 470	CITIZENS	INVOLVING CITIZENS IN METROPOLITAN REGION TRANSPORTATION PLANNING. 1977 FINAL REPORT	HS-021 498
<b>CATALYST</b>				
CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES	HS-021 525	CITY	APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT]	HS-802 725
EMISSIONS FROM IN-USE CATALYST VEHICLES	HS-021 527			
<b>CAUSES</b>			IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS	HS-021 476
TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS: AN OVERVIEW OF FINAL RESULTS	HS-021 602			
<b>CHARACTERISTICS</b>			KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3)	HS-802 717
ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC	HS-021 561			
AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS	HS-021 563		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3)	HS-802 719
INJURY CHARACTERISTICS OF RIDERS OF MOTOR-CYCLES, MINIBIKES, AND MOPEDS	HS-021 594			
TAXICAB OPERATING CHARACTERISTICS. FINAL REPORT	HS-021 482		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-802 720
			KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)	HS-802 724
			KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-802 726

february 28, 1978

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF ALCOHOL REHABILITATION EF-  
FORTS. ANNUAL REPORT NO. 3 (PT. 6)

HS-802 729

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
ANALYSIS OF FIRST TELEPHONE SURVEY

HS-802 728

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
PROFILE STUDIES OF DRIVERS IMPAIRED BY AL-  
COHOL. ANNUAL REPORT NO. 3 (PT. 8)

HS-802 730

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
PUBLIC INFORMATION AND EDUCATION. ANNUAL  
REPORT NO. 3 (PT. 7)

HS-802 727

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 716

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 718

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 722

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1974 ROADSIDE SURVEY

HS-802 723

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1975 ROADSIDE SURVEY

HS-802 731

KANSAS CITY, MISSOURI ALCOHOL SAFETY AC-  
TION PROJECT. ANNUAL REPORT NO. 1, JANUARY  
1-DECEMBER 31, 1972

HS-802 715

KANSAS CITY, MISSOURI ALCOHOL SAFETY AC-  
TION PROJECT. ANNUAL REPORT NO. 3, JANUARY  
1-DECEMBER 31, 1974

HS-802 721

#### CLOSING

EVALUATION OF OCCUPANT PROTECTION  
DEVICES AND RESTRAINT SYSTEMS. TEST REPORT.  
TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRON-  
TAL - CAR-TO-CAR OFFSET PASSENGER TO PAS-  
SENGER 60 MPH CLOSING SPEED

HS-802 686

#### COACHES

IMPROVEMENTS IN THE SAFETY OF URBAN  
TRANSIT COACHES

HS-021 564

#### COLLISION

COLLISION SEVERITY - MEASURED BY (DELTA)V

HS-021 601

#### COLUMBIA

AMERICAN ASSOCIATION FOR AUTOMOTIVE  
MEDICINE. PROCEEDINGS OF THE 21ST CON-  
FERENCE, VANCOUVER, BRITISH COLUMBIA  
[CANADA], SEPTEMBER 15-17, 1977

HS-021 568

BARBITURATES AND ALCOHOL IN B.C. [BRITISH  
COLUMBIA] TRAFFIC FATALITIES

HS-021 587

DEVELOPMENT OF A GOVERNMENT ORGANIZED  
EMERGENCY HEALTH SERVICES SYSTEM IN  
BRITISH COLUMBIA [CANADA]

HS-021 572

#### COMES

WHAT COMES NEXT IN AUTO SAFETY?

HS-021 534

#### COMMERCE

GUIDE FOR MEDICAL EXAMINERS TO DETERMINE  
FITNESS TO DRIVE BUSES AND TRUCKS IN IN-  
TERSTATE COMMERCE

HS-021 583

#### COMMERCIAL

INTERAGENCY STUDY OF POST-1980 GOALS FOR  
COMMERCIAL MOTOR VEHICLES FROM THE PER-  
SPECTIVE OF TRUCK AND BUS MANUFACTURERS

HS-021 556

OVERVIEW OF THE INTERAGENCY STUDY OF  
POST-1980 GOALS FOR COMMERCIAL MOTOR VEH-  
ICLES

HS-021 538

THE HUMAN BEHIND THE WHEEL. INTERNA-  
TIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON  
POST-1980 GOALS FOR COMMERCIAL MOTOR VEH-  
ICLES

HS-021 553

#### COMPATIBILITY

COMPATIBILITY OF DIESEL ENGINES WITH VEH-  
ICLES INCORPORATING ADVANCED CRASHWORTHI-  
NESS

HS-021 548

#### COMPLEXES

IMMUNOLOGICAL STUDIES ON PLATINUM COM-  
PLEXES AND THEIR POSSIBLE RELEVANCE TO AU-  
TOCATALYSTS

HS-021 524

#### COMPLIANCE

REPORT TO THE PRESIDENT ON COMPLIANCE  
WITH THE 55 MPH SPEED LIMIT

HS-021 502

#### COMPOUNDS

EVALUATION OF TEST DUMMY'S FLESH PARTS  
PRODUCED WITH SUBSTITUTE FOAMING COM-  
POUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER  
TO 30 SEPTEMBER 1977

HS-021 709

#### COMPREHENSIVE

A METHOD FOR THE COMPREHENSIVE RECORDING  
AND ANALYSIS OF THE EFFECTIVENESS OF AN  
EMERGENCY MEDICAL SYSTEM IN AN URBAN AND  
RURAL AREA

HS-021 573

#### COMPROMISES

EVALUATION OF THE COMPROMISES AMONG  
SAFETY, WEIGHT, COST AND SERVICE

HS-021 552

#### COMPUTER

COMPUTER SIMULATION OF LARGE-DISPLACEMENT  
IMPACT DYNAMICS

HS-021 518

	HSL 78-02
FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472
SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM	HS-021 516
TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM	HS-021 469
<b>COMPUTERIZED</b>	
A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS	HS-021 532
COMPUTERIZED FIVE PARAMETER ENGINE MAPPING	HS-021 533
<b>CONCEPT</b>	
A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION	HS-021 537
INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT	HS-021 485
SAFETY VILLAGE CONCEPT	HS-021 581
VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA	HS-021 555
<b>CONCEPTS</b>	
INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT	HS-021 485
INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT	HS-021 486
<b>CONCEPTUAL</b>	
ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC	HS-021 561
<b>CONDUCTED</b>	
FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.	HS-021 540
<b>CONFERENCE</b>	
AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CON-	HS-021 599
ERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977	HS-021 568
<b>CONFIGURATION</b>	
EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION	HS-021 468
<b>CONGRESS</b>	
CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS	HS-021 471
<b>CONSERVATION</b>	
ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT	HS-021 566
<b>CONSTRAINTS</b>	
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS	HS-021 529
<b>CONTEXT</b>	
1976 VEHICLE LOW SPEED IMPACT TESTING: EVALUATION IN THE CONTEXT OF FMVSS 215	HS-021 508
<b>CONTROL</b>	
DRIVER CONTROL IN THE TRUCKING INDUSTRY	HS-021 582
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS	HS-021 529
HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976	HS-021 496
<b>CONTROLS</b>	
SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT	HS-021 497
<b>CONVINCING</b>	
CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS	HS-021 471
<b>CORD</b>	
DEVELOPMENT OF GLASS FIBER TIRE CORD	HS-021 499
MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS	HS-021 593
<b>CORONER</b>	
THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE	HS-021 599

february 28, 1978

**CORPORATION**

GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY

HS-021 483

**COST**

EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE

HS-021 552

THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS

HS-021 554

**COSTS**

ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS

HS-021 591

**CRASH**

A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT

HS-021 492

AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS

HS-021 563

EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS

HS-021 567

THE ROLE OF THE MEDICAL EXAMINER IN CRASH INVESTIGATION

HS-021 598

THE SAFEST WAY TO CRASH...DON'T. AN EXAMINATION OF EMERGENCY BRAKING TECHNIQUES

HS-021 481

**CRASHES**

A STUDY OF SOME SCHOOLBUS CRASHES

HS-021 585

**CRASHWORTHINESS**

COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS

HS-021 548

THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS

HS-021 554

**CROSSING**

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT

HS-021 485

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST

WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT

HS-021 486

**CURRICULUM**

ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS

HS-021 590

**CUSHION**

USE OF SODIUM AZIDE FOR AIR CUSHION INFLATOR

HS-021 484

**CUSTOMER**

CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE

HS-021 557

**DAMAGE**

AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS

HS-021 563

TOYOTA'S LIGHT-WEIGHT ELASTOMER BUMPER NO-DAMAGE

HS-021 544

**DASHBOARD**

DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?

HS-021 592

**DECade**

A DECADE OF RESEARCH IN VEHICLE REAR LIGHTING: WHAT HAVE WE LEARNED?

HS-021 577

**DECISIONS**

CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S

HS-021 541

**DEFECTIVE**

CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S

HS-021 541

**DEFLECTIONS**

DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS

HS-021 514

**DEFORMATION**

A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES

HS-021 517

<b>DEGREE</b> A DEGREE PROGRAM FOR EMS ADMINISTRATORS - A UNIQUE APPROACH	HS-021 574	<b>DIAGNOSTIC</b> A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION	HS-021 537
<b>DELAY</b> A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 1. TECHNICAL REPORT. FINAL REPORT	HS-021 607	VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA	HS-021 555
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT	HS-021 608	DIESEL	
COLLISION SEVERITY - MEASURED BY (DELTA)V	HS-021 601	COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS	HS-021 548
<b>DEMAND</b> TRAFFIC AS A FUNCTION OF SUPPLY AND DEMAND	HS-021 475	DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980	HS-021 539
<b>DEMONSTRATED</b> VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA	HS-021 555	OLDSMOBILE OPTS FOR DIESEL POWER	HS-021 610
<b>DEPARTMENT</b> FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES	HS-020 978	<b>DIMENSIONAL</b> DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS	HS-021 514
GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY	HS-021 483	<b>DIRECT</b> ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS	HS-021 591
<b>DEPARTURE</b> MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES	HS-802 303	<b>DISEASE</b> DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY	HS-021 575
<b>DESIGNED</b> EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567	<b>DISPLACEMENT</b> COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS	HS-021 518
<b>DEVICES</b> EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED	HS-802 686	<b>DISTANCE</b> FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472
<b>DIAGNOSIS</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-802 720	<b>DOOR</b> THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY	HS-021 578
INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM	HS-021 494	<b>DRAIN</b> MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?	HS-020 722
<b>DRINKER</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-802 720	<b>DRAM</b>	

february 28, 1978

<b>DRIVE</b>		
FRONT-WHEEL DRIVE	HS-021 479	A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES
GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE	HS-021 583	HS-021 517
		DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS
<b>DRIVER</b>		HS-021 514
DRIVER CONTROL IN THE TRUCKING INDUSTRY	HS-021 582	DYNAMIC ANALYSIS OF MACHINERY VIA PROGRAM DYMAC
		HS-021 503
<b>DRIVERS</b>		DYNAMIC MODELS OF THE U.S. AUTOMOBILE FLEET. FINAL REPORT
FATALLY INJURED TRUCK DRIVERS	HS-021 600	HS-021 489
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY ALCOHOL. ANNUAL REPORT NO. 3 (PT. 8)	HS-802 730	NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS
MEDICAL REPORTING OF DRIVERS WITH EMOTIONAL PROBLEMS	HS-021 576	HS-021 515
ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN CANADA	HS-021 589	VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION
		HS-021 521
<b>DRIVING</b>		
ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS	HS-021 590	<b>DYNAMICS</b>
DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY	HS-021 575	COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS
HABIT CHECK OF SEEING AND RESPONDING IN DRIVING	HS-021 477	HS-021 518
THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING-RELATED SKILLS PERFORMANCE	HS-021 588	STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 1. DESCRIPTION. FINAL REPORT
		HS-021 487
<b>DUMMY</b>		STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 2. ANALYSIS. FINAL REPORT
EVALUATION OF TEST DUMMY'S FLESH PARTS PRODUCED WITH SUBSTITUTE FOAMING COMPOUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER TO 30 SEPTEMBER 1977	HS-802 709	HS-021 488
		TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM
		HS-021 469
<b>ECONOMICS</b>		
BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES	HS-021 599	<b>DYNAMOMETER</b>
		EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS
<b>ECONOMY</b>		HS-021 523
GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY	HS-021 483	
		<b>ECONOMICS</b>
DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980	HS-021 539	BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES
		HS-021 559
<b>DYMAC</b>		
DYNAMIC ANALYSIS OF MACHINERY VIA PROGRAM DYMAC	HS-021 503	<b>ECONOMY</b>
		ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS
<b>DYNAMIC</b>		HS-021 529
A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION	HS-021 537	OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS
		HS-021 530
		THE IMPORTANCE OF AUTOMOTIVE FUEL ECONOMY STANDARDS
		HS-021 546
<b>EDUCATION</b>		
ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS	HS-021 590	

HSL 78-02

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7)	HS-021 525	EMISSIONS
		CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES
EDUCATIONAL	HS-021 527	
EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS		
	HS-021 567	
EFFECTIVE		EMOTIONAL
THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS		MEDICAL REPORTING OF DRIVERS WITH EMOTIONAL PROBLEMS
	HS-021 554	
EFFECTIVENESS		
A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA		
	HS-021 573	
EFFICIENT		EMPLOYING
CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS		EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION
	HS-021 471	
EFFORTS		
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT NO. 3 (PT. 6)		
	HS-021 729	
ELASTOMER		EMS
TOYOTA'S LIGHT-WEIGHT ELASTOMER BUMPER	NO-DAMAGE	A DEGREE PROGRAM FOR EMS ADMINISTRATORS - A UNIQUE APPROACH
	HS-021 544	
ELASTOMERIC		
ELASTOMERIC USE IN 1978 AUTOS		
	HS-021 501	
EMERGENCY		ENERGY
A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA		ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT
	HS-021 573	
DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]		
	HS-021 572	
EMERGENCY MEDICAL SERVICES		BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES
	HS-021 597	
THE SAFEST WAY TO CRASH...DON'T. AN EXAMINATION OF EMERGENCY BRAKING TECHNIQUES		ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE
	HS-021 481	
EMISSION		THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS		
	HS-021 529	
		ENGINE
		A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS
		HS-021 532
		COMPUTERIZED FIVE PARAMETER ENGINE MAPPING
		HS-021 533
		EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION
		HS-021 468
		ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS
		HS-021 529
		ENGINE MAPPING METHODOLOGY
		HS-021 531
		OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS
		HS-021 530
		TRANSIENT RESPONSE OF A CARBURETOR ENGINE
		HS-021 467
		VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE
		HS-021 466

february 28, 1978

VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS HS-020 916

**ENGINES**

COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS HS-021 548

DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980 HS-021 539

UNDERSTANDING ENGINES. SUCK, SQUEEZE, POP, PHOOEY HS-021 513

**ENVIRONMENT**

ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT HS-021 566

BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES HS-021 559

INVESTIGATING THE ROADWAY ENVIRONMENT HS-021 595

**ENVIRONMENTAL**

THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY HS-021 526

**EQUIPPED**

CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES HS-021 525

ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA] HS-021 584

**EQUITABLENESS**

ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT HS-021 566

**ESSENTIAL**

THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS HS-021 554

**ESTABLISHMENT**

ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA] HS-021 584

**ETHICAL**

THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY) HS-021 551

**EVALUATION**

A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION HS-021 537

ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT HS-021 605

ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT HS-021 606

EVALUATION OF A HUB ASSEMBLY HS-021 480

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED HS-802 686

EVALUATION OF SULFATE TRAPPING CANDIDATES-RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS HS-021 523

EVALUATION OF TEST DUMMY'S FLESH PARTS PRODUCED WITH SUBSTITUTE FOAMING COMPOUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER TO 30 SEPTEMBER 1977 HS-802 709

EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE HS-021 552

EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS HS-021 567

GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY HS-021 483

THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND APPROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS HS-802 302

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 691

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 692

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 693

HSL 78-02

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET	HS-802 694	EVOLVED THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY)	HS-021 551
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET	HS-802 695	EXAMINATION THE SAFEST WAY TO CRASH...DON'T. AN EXAMINATION OF EMERGENCY BRAKING TECHNIQUES	HS-021 481
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER	HS-802 696	EXAMINER THE ROLE OF THE MEDICAL EXAMINER IN CRASH INVESTIGATION	HS-021 598
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER	HS-802 697	EXAMINERS GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE	HS-021 583
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 698	EXHAUST EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION	HS-021 468
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 699	TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST	HS-021 522
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 700	EXTENSION MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?	HS-020 722
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT	HS-802 701	EXTENT CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S	HS-021 541
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 702	FATAL A PROFILE OF FATAL ACCIDENTS INVOLVING ALCOHOL	HS-021 586
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT	HS-802 703	FATALITIES BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 704	MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES	HS-802 303
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON	HS-802 705	FATALLY FATALLY INJURED TRUCK DRIVERS	HS-021 600
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT	HS-802 706	FEASIBILITY STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS	HS-021 490
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 707		
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT	HS-802 708		
1976 VEHICLE LOW SPEED IMPACT TESTING: EVALUATION IN THE CONTEXT OF FMVSS 215	HS-021 508		

february 28, 1978

**FEDERAL**

OVERVIEW OF THE REPORT OF THE FEDERAL  
TASK FORCE ON MOTOR VEHICLE GOALS BEYOND  
1980

HS-021 549

**Fee**

Fee structure of the Department of Motor  
Vehicles. A study of alternatives for  
restructuring and updating fees charged  
for registration, licensing, and related  
services

HS-020 978

**FEES**

Fee structure of the Department of Motor  
Vehicles. A study of alternatives for  
restructuring and updating fees charged  
for registration, licensing, and related  
services

HS-020 978

**FIBER**

Development of glass fiber tire cord

HS-021 499

**FITNESS**

Guide for medical examiners to determine  
fitness to drive buses and trucks in  
interstate commerce

HS-021 583

**FLAME**

Validation of a turbulent flame propagation  
model for a spark ignition engine

HS-021 466

**FLEET**

Dynamic models of the U.S. automobile  
fleet. Final report

HS-021 489

Fleet vehicles today and tomorrow. The  
results of a survey conducted by the  
National Association of Fleet Administrators,  
Inc.

HS-021 540

**FLESH**

Evaluation of test dummy's flesh parts  
produced with substitute foaming com-  
pounds. Progress report no. 7, 1 SEPTEMBER  
TO 30 SEPTEMBER 1977

HS-802 709

**FMVSS**

1976 vehicle low speed impact testing:  
Evaluation in the context of FMVSS 215

HS-021 508

**FOAMING**

Evaluation of test dummy's flesh parts  
produced with substitute foaming com-  
pounds. Progress report no. 7, 1 SEPTEMBER  
TO 30 SEPTEMBER 1977

HS-802 709

**FORCE**

OVERVIEW OF THE REPORT OF THE FEDERAL  
TASK FORCE ON MOTOR VEHICLE GOALS BEYOND  
1980

HS-021 549

**FORMULATION**

NON-LINEAR MODEL FORMULATION FOR THE  
STATIC AND DYNAMIC ANALYSES OF FRONT  
SUSPENSIONS

HS-021 515

**FREE**

THE BETTER THINGS IN LIFE ARE NOT FREE

HS-021 558

**FREEWAY**

MULTIDISCIPLINARY ACCIDENT INVESTIGATION:  
FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS  
ROLLOVER; 29 FATALITIES

HS-802 303

**FRICITION**

INTERACTIVE SIMULATION OF MACHINERY WITH  
FRICTION AND IMPACT USING DRAM

HS-021 494

**FRONT**

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 11, 3  
MAY 1976 TO 6 JUNE 1976

HS-802 671

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 12, 7  
JUNE 1976 TO 6 JULY 1976

HS-802 672

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 13, 5  
JULY 1976 TO 8 AUGUST 1976

HS-802 673

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AU-  
GUST 1976 TO 12 SEPTEMBER 1976

HS-802 674

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 15, 13  
SEPTEMBER 1976 TO 10 OCTOBER 1976

HS-802 675

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 16, 11  
OCTOBER 1976 TO 7 NOVEMBER 1976

HS-802 676

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 17, 8  
NOVEMBER 1976 TO 5 DECEMBER 1976

HS-802 677

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT

**HSL 78-02**

SEAT PASSENGER. PROGRESS REPORT NO. 18, 6  
DECEMBER 1976 TO 9 JANUARY 1977

HS-802 678

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 19, 10  
JANUARY 1977 TO 13 FEBRUARY 1977

HS-802 679

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 20, 14  
FEBRUARY 1977 TO 13 MARCH 1977

HS-802 680

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 21, 14  
MARCH 1977 TO 10 APRIL 1977

HS-802 681

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 22, 11  
APRIL 1977 TO 1 MAY 1977

HS-802 682

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 23, 2  
MAY 1977 TO 5 JUNE 1977

HS-802 683

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 24, 6  
JUNE 1977 TO 10 JULY 1977

HS-802 684

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 25, 11  
JULY 1977 TO 14 AUGUST 1977

HS-802 685

FRONT-WHEEL DRIVE

HS-021 479

NON-LINEAR MODEL FORMULATION FOR THE  
STATIC AND DYNAMIC ANALYSES OF FRONT  
SUSPENSIONS

HS-021 515

FRONTAL

EVALUATION OF OCCUPANT PROTECTION  
DEVICES AND RESTRAINT SYSTEMS. TEST REPORT.  
TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRON-  
TAL - CAR-TO-CAR OFFSET PASSENGER TO PAS-  
SENGER 60 MPH CLOSING SPEED

HS-802 686

FUEL

CONVINCING THE PUBLIC TO BUY THE MORE  
FUEL-EFFICIENT CARS: AN URGENT NATIONAL  
NEED. REPORT TO THE CONGRESS

HS-021 471

ENGINE CONTROL OPTIMIZATION FOR BEST FUEL  
ECONOMY WITH EMISSION CONSTRAINTS

HS-021 529

OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRA-  
TION FOR BETTER FUEL ECONOMY--METHODS  
AND APPLICATIONS

HS-021 530

THE IMPORTANCE OF AUTOMOTIVE FUEL ECONO-  
MY STANDARDS

HS-021 546

**FUNCTION**

TRAFFIC AS A FUNCTION OF SUPPLY AND DE-  
MAND

HS-021 475

**GASEOUS**

CHARACTERIZATION OF SULFATE AND GASEOUS  
EMISSIONS FROM CALIFORNIA CONSUMER-  
OWNED, CATALYST-EQUIPPED VEHICLES

HS-021 525

**GASOLINE**

TRAVEL BEHAVIOR UNDER INCREASES IN  
GASOLINE PRICES

HS-021 474

**GENERATION**

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR  
RAILROAD-HIGHWAY GRADE CROSSING MOTORIST  
WARNING SYSTEMS. VOL. 1. OVERVIEW AND CON-  
CEPT GENERATION AND ANALYSIS. FINAL REPORT

HS-021 485

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR  
RAILROAD-HIGHWAY GRADE CROSSING MOTORIST  
WARNING SYSTEMS. VOL. 2. THE GENERATION  
AND ANALYSIS OF ALTERNATIVE CONCEPTS.  
FINAL REPORT

HS-021 486

**GLASS**

DEVELOPMENT OF GLASS FIBER TIRE CORD

HS-021 499

**GOAL**

FIELD RELEVANT TESTS: OUR MOST IMPORTANT  
MOTOR VEHICLE GOAL

HS-021 560

**GOALS**

INTERAGENCY STUDY OF POST-1980 GOALS FOR  
COMMERCIAL MOTOR VEHICLES FROM THE PER-  
SPECTIVE OF TRUCK AND BUS MANUFACTURERS

HS-021 556

OVERVIEW OF THE INTERAGENCY STUDY OF  
POST-1980 GOALS FOR COMMERCIAL MOTOR VEH-  
ICLES

HS-021 538

OVERVIEW OF THE REPORT OF THE FEDERAL  
TASK FORCE ON MOTOR VEHICLE GOALS BEYOND  
1980

HS-021 549

THE HUMAN BEHIND THE WHEEL. INTERNA-  
TIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON  
POST-1980 GOALS FOR COMMERCIAL MOTOR VEH-  
ICLES

HS-021 553

**GOVERNMENT**

DEVELOPMENT OF A GOVERNMENT ORGANIZED  
EMERGENCY HEALTH SERVICES SYSTEM IN  
BRITISH COLUMBIA [CANADA]

HS-021 572

february 28, 1978

**GOVERNMENTAL**

CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S

HS-021 541

**GRADE**

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT

HS-021 485

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT

HS-021 486

**GUIDE**

GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE

HS-021 583

**HABIT**

HABIT CHECK OF SEEING AND RESPONDING IN DRIVING

HS-021 477

**HABITS**

CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE

HS-021 557

**HAZARDOUS**

HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976

HS-021 496

IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS

HS-021 476

**HEAD**

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-021 691

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-021 692

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-021 693

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-021 698

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-021 699

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-021 705

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-021 707

**HEADLAMP**

FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT

HS-021 472

**HEALTH**

DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]

HS-021 572

**HELMET**

IMPACT OF MOTORCYCLE HELMET LAW REPEAL

HS-021 569

**HIGHWAY**

ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC

HS-021 561

HIGHWAY STATISTICS. SUMMARY TO 1975

HS-021 609

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT

HS-021 485

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT

HS-021 486

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977

HS-021 689

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977

HS-021 690

STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS

HS-021 490

HSL 78-02

THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND APPROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS	HS-802 302	IMPACT	COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS	HS-021 518
<b>HOUSEHOLD</b>		IMPACT OF MOTORCYCLE HELMET LAW REPEAL	HS-021 569	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 716	INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM	HS-021 494	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 718	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-802 726	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 722	THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW	HS-021 570	
<b>HUB</b>		1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4	HS-021 504	
EVALUATION OF A HUB ASSEMBLY	HS-021 480	1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B	HS-021 505	
<b>HUMAN</b>		1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C	HS-021 506	
THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553	1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D	HS-021 507	
VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION	HS-021 521	1976 VEHICLE LOW SPEED IMPACT TESTING: EVALUATION IN THE CONTEXT OF FMVSS 215	HS-021 508	
<b>HYBRID</b>		1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4	HS-021 509	
GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY	HS-021 483	1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B	HS-021 510	
<b>IDENTIFICATION</b>		1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C	HS-021 511	
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605	1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D	HS-021 512	
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 606	<b>IMPAIRED</b>		
IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS	HS-021 476	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY ALCOHOL. ANNUAL REPORT NO. 3 (PT. 8)	HS-802 730	
<b>IGNITION</b>		ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN CANADA	HS-021 589	
VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE	HS-021 466	<b>IMPLICATIONS</b>		
<b>IMMUNOLOGICAL</b>		INCOMPATIBLE STANDARDS AND THEIR IMPLICATIONS FOR AUTOMOTIVE MEDICINE	HS-021 603	
IMMUNOLOGICAL STUDIES ON PLATINUM COMPLEXES AND THEIR POSSIBLE RELEVANCE TO AUTOCATALYSTS	HS-021 524	KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES	HS-021 519	

february 28, 1978

<b>IMPORTANCE</b>		<b>INFANTS</b>	
THE IMPORTANCE OF AUTOMOTIVE FUEL ECONOMY STANDARDS	HS-021 546	EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567
<b>IMPORTANT</b>		<b>INFLATION</b>	
FIELD RELEVANT TESTS: OUR MOST IMPORTANT MOTOR VEHICLE GOAL	HS-021 560	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 11, 3 MAY 1976 TO 6 JUNE 1976	HS-802 671
<b>IMPROVEMENTS</b>		DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 12, 7 JUNE 1976 TO 6 JULY 1976	HS-802 672
IMPROVEMENTS IN THE SAFETY OF URBAN TRANSIT COACHES	HS-021 564	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 13, 5 JULY 1976 TO 8 AUGUST 1976	HS-802 673
<b>INCOMPATIBLE</b>		DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AUGUST 1976 TO 12 SEPTEMBER 1976	HS-802 674
INCOMPATIBLE STANDARDS AND THEIR IMPLICATIONS FOR AUTOMOTIVE MEDICINE	HS-021 603	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 15, 13 SEPTEMBER 1976 TO 10 OCTOBER 1976	HS-802 675
<b>INCORPORATING</b>		DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 16, 11 OCTOBER 1976 TO 7 NOVEMBER 1976	HS-802 676
COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS	HS-021 548	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 17, 8 NOVEMBER 1976 TO 5 DECEMBER 1976	HS-802 677
<b>INCREASE</b>		DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 18, 6 DECEMBER 1976 TO 9 JANUARY 1977	HS-802 678
EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 19, 10 JANUARY 1977 TO 13 FEBRUARY 1977	HS-802 679
<b>INCREASES</b>		DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 20, 14 FEBRUARY 1977 TO 13 MARCH 1977	HS-802 680
TRAVEL BEHAVIOR UNDER INCREASES IN GASOLINE PRICES	HS-021 474	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 21, 14 MARCH 1977 TO 10 APRIL 1977	HS-802 681
<b>INDICATED</b>		DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 22, 10 APRIL 1977 TO 12 MAY 1977	HS-802 682
CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S	HS-021 541		
<b>INDIRECT</b>			
STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS	HS-021 490		
<b>INDUCED</b>			
CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S	HS-021 541		
<b>INDUSTRY</b>			
DRIVER CONTROL IN THE TRUCKING INDUSTRY	HS-021 582		
LOSS PREVENTION: THE CONSUMER'S AND THE INDUSTRY'S RESPONSIBILITIES	HS-810 308		

HSL 78-02

SEAT PASSENGER. PROGRESS REPORT NO. 22, 11  
APRIL 1977 TO 1 MAY 1977

HS-802 682

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 23, 2  
MAY 1977 TO 5 JUNE 1977

HS-802 683

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 24, 6  
JUNE 1977 TO 10 JULY 1977

HS-802 684

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 25, 11  
JULY 1977 TO 14 AUGUST 1977

HS-802 685

#### INFLATOR

USE OF SODIUM AZIDE FOR AIR CUSHION INFLA-  
TOR

HS-021 484

#### INFORMATION

AUTOMOBILE CRASH DAMAGE: USE OF REPAIR IN-  
FORMATION FOR EVALUATING AUTOMOBILE  
DESIGN CHARACTERISTICS

HS-021 563

GENERAL MOTORS CORPORATION RESPONSE TO  
THE DEPARTMENT OF TRANSPORTATION REQUEST  
FOR INFORMATION ON THE EVALUATION OF THE  
HYBRID III DUMMY

HS-021 483

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
PUBLIC INFORMATION AND EDUCATION. ANNUAL  
REPORT NO. 3 (PT. 7)

HS-802 727

#### INJURED

FATALLY INJURED TRUCK DRIVERS

HS-021 600

#### INJURIES

ROAD INJURIES IN QUEBEC [CANADA] (1974): NA-  
TURE, SEVERITY AND DIRECT COSTS

HS-021 591

#### INJURY

INJURY CHARACTERISTICS OF RIDERS OF MOTOR-  
CYCLES, MINIBIKES, AND MOPEDS

HS-021 594

INVESTIGATION OF INJURY MECHANISMS AS-  
SOCIATED WITH FULLY RESTRAINED PASSENGER  
VEHICLE OCCUPANTS IN LONDON, ONTARIO  
[CANADA]

HS-021 579

MECHANISMS OF SPINAL CORD INJURY (SCI) IN  
VEHICLE OCCUPANTS

HS-021 593

THE EFFECT OF SIDE DOOR REINFORCEMENT  
BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS  
ON INJURY SEVERITY

HS-021 578

#### INNOVATIVE

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR  
RAILROAD-HIGHWAY GRADE CROSSING MOTORIST  
WARNING SYSTEMS. VOL. 1. OVERVIEW AND CON-  
CEPT GENERATION AND ANALYSIS. FINAL REPORT  
HS-021 485

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR  
RAILROAD-HIGHWAY GRADE CROSSING MOTORIST  
WARNING SYSTEMS. VOL. 2. THE GENERATION  
AND ANALYSIS OF ALTERNATIVE CONCEPTS.  
FINAL REPORT

HS-021 486

#### INQUEST

THE CORONER'S SYSTEM IN ONTARIO, CANADA:  
INVESTIGATION AND INQUEST IN AUTOMOTIVE  
MEDICINE

HS-021 599

#### INSPECTION

THE NEED FOR AND BENEFITS OF INSPECTION  
AND MAINTENANCE OF IN-USE MOTOR VEHICLES  
HS-021 565

VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC  
INSPECTION CONCEPT DEMONSTRATED BY NHTSA  
HS-021 555

#### INTEGRATION

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 691

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 692

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 693

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET  
HS-802 694

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET  
HS-802 695

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 6. TEST TYPE: CAR-TO-BARRIER  
HS-802 696

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 7. TEST TYPE: CAR-TO-BARRIER  
HS-802 697

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 698

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 699

february 28, 1978

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 700	A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT	HS-021 608	
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT	HS-802 701	INTERSTATE	GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE	HS-021 583
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 702	INTOXICATED	ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS	HS-021 590
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT	HS-802 703	INVESTIGATING	INVESTIGATING THE ROADWAY ENVIRONMENT	HS-021 595
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 704	INVESTIGATION	A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT	HS-021 492
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON	HS-802 705	INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]	HS-021 579	
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT	HS-802 706	MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES	HS-802 303	
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 707	THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE	HS-021 599	
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT	HS-802 708	THE ROLE OF THE MEDICAL EXAMINER IN CRASH INVESTIGATION	HS-021 598	
<b>INTERACTIVE</b>		THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"	HS-021 596	
INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM	HS-021 494	<b>IONIZATION</b>	THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY	HS-021 526
<b>INTERAGENCY</b>		<b>ISSUES</b>	SYMPOSIUM ON CURRENT ISSUES IN TRANSPORTATION POLICY	HS-021 495
INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS	HS-021 556	<b>JUDGES</b>	CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S	HS-021 541
OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 538	<b>JURORS</b>	CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY	
<b>INTERNATIONAL</b>				
THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553			
INTERSECTIONS				
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 1. TECHNICAL REPORT. FINAL REPORT	HS-021 607			

		HSL 78-02
DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S	HS-021 541	
<b>JUSTICE</b>		
ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT	HS-021 566	
<b>KANSAS</b>		
APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT]	HS-021 725	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3)	HS-021 717	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3)	HS-021 719	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-021 720	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)	HS-021 724	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-021 726	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT NO. 3 (PT. 6)	HS-021 729	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY	HS-021 728	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY ALCOHOL. ANNUAL REPORT NO. 3 (PT. 8)	HS-021 730	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7)	HS-021 727	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-021 716	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-021 718	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-021 722	
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY HS-802 723
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY HS-802 731
		KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 1, JANUARY 1-DECEMBER 31, 1972 HS-802 715
		KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 3, JANUARY 1-DECEMBER 31, 1974 HS-802 721
		KEY HS-021 551
		THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY)
		KINEMATICAL HS-021 519
		KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES
		KNEE HS-021 592
		DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?
		LARGE HS-021 517
		A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES
		COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS HS-021 518
		DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS HS-021 514
		LAW HS-021 496
		HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976
		IMPACT OF MOTORCYCLE HELMET LAW REPEAL HS-021 569
		THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW HS-021 570
		LEAD HS-021 522
		TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST
		LEARNED HS-021 577
		A DECADE OF RESEARCH IN VEHICLE REAR LIGHTING: WHAT HAVE WE LEARNED?

february 28, 1978

**LEFT**

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 701

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 703

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT

HS-802 706

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT

HS-802 708

**LENSES**

DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT

HS-021 491

**LEVEL**

TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS: AN OVERVIEW OF FINAL RESULTS

HS-021 602

**LICENSING**

FEES STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES

HS-020 978

**LIFE**

THE BETTER THINGS IN LIFE ARE NOT FREE

HS-021 558

**LIGHTING**

A DECADE OF RESEARCH IN VEHICLE REAR LIGHTING: WHAT HAVE WE LEARNED?

HS-021 577

**LIGHTS**

THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW

HS-021 570

**LIMIT**

REPORT TO THE PRESIDENT ON COMPLIANCE WITH THE 55 MPH SPEED LIMIT

HS-021 502

**LIMITATION**

PROGRAM PRIORITY AND LIMITATION ANALYSIS. FINAL REPORT

HS-802 320

**LINE**

A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS

HS-021 532

**LINEAR**

NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS

HS-021 515

**LITIGATION**

CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S

HS-021 541

**LOCATIONS**

IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS

HS-021 476

**LONDON**

INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]

HS-021 579

**LOSS**

LOSS PREVENTION: THE CONSUMER'S AND THE INDUSTRY'S RESPONSIBILITIES

HS-810 308

**LOW**

VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS

HS-020 916

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4

HS-021 504

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B

HS-021 505

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C

HS-021 506

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D

HS-021 507

1976 VEHICLE LOW SPEED IMPACT TESTING: EVALUATION IN THE CONTEXT OF FMVSS 215

HS-021 508

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4

HS-021 509

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B

HS-021 510

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C

HS-021 511

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D

HS-021 512

**MACHINERY**

DYNAMIC ANALYSIS OF MACHINERY VIA PROGRAM DYMAC

HS-021 503

INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM

HS-021 494

HSL 78-02		
<b>MAINTENANCE</b>		
CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE		HS-021 557
THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES		HS-021 565
<b>MANAGEMENT</b>		
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT		HS-021 605
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT		HS-021 606
<b>MANIFOLD</b>		
EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION		HS-021 468
<b>MANUAL</b>		
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT		HS-021 608
<b>MANUFACTURERS</b>		
INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS		HS-021 556
<b>MAPPING</b>		
COMPUTERIZED FIVE PARAMETER ENGINE MAPPING		HS-021 533
ENGINE MAPPING METHODOLOGY		HS-021 531
<b>MARKET</b>		
ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT		HS-021 470
STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 1. DESCRIPTION. FINAL REPORT		HS-021 487
STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 2. ANALYSIS. FINAL REPORT		HS-021 488
<b>MASS</b>		
THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY		HS-021 526
<b>MATERIALS</b>		
HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976		HS-021 496
<b>MAXIMIZING</b>		
MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD - WHAT'S REQUIRED?		HS-020 722
<b>MEASURED</b>		
COLLISION SEVERITY - MEASURED BY (DELTA)V		HS-021 601
<b>MEASUREMENT</b>		
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 1. TECHNICAL REPORT. FINAL REPORT		HS-021 607
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT		HS-021 608
<b>MEASURES</b>		
A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT		HS-021 492
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)		HS-802 726
<b>MECHANISMS</b>		
INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]		HS-021 579
MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS		HS-021 593
<b>MEDICAL</b>		
A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA		HS-021 573
EMERGENCY MEDICAL SERVICES		HS-021 597
GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE		HS-021 583
MEDICAL REPORTING OF DRIVERS WITH EMOTIONAL PROBLEMS		HS-021 576
THE ROLE OF THE MEDICAL EXAMINER IN CRASH INVESTIGATION		HS-021 598

february 28, 1978

**MEDICINE**

AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CONFERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977

HS-021 568

INCOMPATIBLE STANDARDS AND THEIR IMPLICATIONS FOR AUTOMOTIVE MEDICINE

HS-021 603

THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE

HS-021 599

**METHOD**

A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA

HS-021 573

**METHODOLOGY**

ENGINE MAPPING METHODOLOGY

HS-021 531

**METHODS**

OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS

HS-021 530

SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS

HS-021 528

**METROPOLITAN**

INVOLVING CITIZENS IN METROPOLITAN REGION TRANSPORTATION PLANNING. 1977 FINAL REPORT

HS-021 498

**MICHIGAN**

ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT

HS-021 470

**MINIBIKES**

INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS

HS-021 594

**MINICARS**

MINICARS RSV BRAKE SYSTEM

HS-021 535

**MISSOURI**

APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT]

HS-802 725

KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 1, JANUARY 1-DECEMBER 31, 1972

HS-802 715

KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 3, JANUARY 1-DECEMBER 31, 1974

HS-802 721

**MOBILITY**

BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES

HS-021 559

**MODEL**

DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS

HS-021 514

NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS

HS-021 515

VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE

HS-021 466

**MODELING**

VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION

HS-021 521

**MODELS**

DYNAMIC MODELS OF THE U.S. AUTOMOBILE FLEET. FINAL REPORT

HS-021 489

**MOLECULAR**

THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY

HS-021 526

**MONDAY**

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977

HS-802 689

**MONITORING**

ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT

HS-021 606

**MOPEDS**

INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS

HS-021 594

**MOTOR**

A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION

HS-021 537

ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL

HSL 78-02

PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC

HS-021 561

ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]

HS-021 584

Fee structure of the department of motor vehicles. A study of alternatives for restructuring and updating fees charged for registration, licensing, and related services

HS-020 978

FIELD RELEVANT TESTS: OUR MOST IMPORTANT MOTOR VEHICLE GOAL

HS-021 560

INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS

HS-021 556

OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES

HS-021 538

OVERVIEW OF THE REPORT OF THE FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980

HS-021 549

THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES

HS-021 553

THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES

HS-021 565

VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA

HS-021 555

**MOTORCYCLE**

IMPACT OF MOTORCYCLE HELMET LAW REPEAL

HS-021 569

THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW

HS-021 570

**MOTORCYCLES**

INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS

HS-021 594

**MOTORIST**

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT

HS-021 485

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT

HS-021 486

**MOTORS**

GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY

HS-021 483

**MULTIDISCIPLINARY**

MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES

HS-802 303

**NATIONAL**

CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS

HS-021 471

FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.

HS-021 540

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977

HS-802 689

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977

HS-802 690

THE NATIONAL ACCIDENT SAMPLING SYSTEM - A STATUS REPORT

HS-021 604

**NATURE**

ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS

HS-021 591

**NEED**

CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS

HS-021 471

THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES

HS-021 565

**NEXT**

WHAT COMES NEXT IN AUTO SAFETY?

HS-021 534

**NHTSA**

THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND APPROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS

HS-802 302

VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA

HS-021 555

february 28, 1978

<b>NORMAL</b> WHEN STATISTICS AREN'T QUITE NORMAL	HS-021 500	<b>OILS</b> VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS	HS-020 916
<b>OCCUPANT</b> EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED	HS-802 686	<b>OLDSMOBILE</b> OLDSMOBILE OPTS FOR DIESEL POWER	HS-021 610
STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?	HS-021 536	<b>ONTARIO</b> ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]	HS-021 584
THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS	HS-021 554	INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]	HS-021 579
<b>OCCUPANTS</b> INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]	HS-021 579	THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE	HS-021 599
MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS	HS-021 593	<b>OPERATING</b> TAXICAB OPERATING CHARACTERISTICS. FINAL REPORT	HS-021 482
<b>ODOMETERS</b> TESTING OF VEHICLE SPEEDOMETERS AND ODOMETERS FOR ACCURACY. FINAL REPORT	HS-802 713	<b>OPERATOR</b> A TRANSIT OPERATOR VIEWS TRANSBUS	HS-021 543
<b>OFFENDERS</b> ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS	HS-021 590	<b>OPINION</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 716
<b>OFFSET</b> EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED	HS-802 686	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 718
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET	HS-802 694	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 722
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET	HS-802 695	<b>OPTIMIZATION</b> ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS	HS-021 529
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT	HS-802 708	OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS	HS-021 530
<b>OIL</b> MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?	HS-020 722	<b>OPTIMUM</b> A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS	HS-021 532
		<b>OPTION</b> ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION	HS-021 562
		<b>OPTS</b> OLDSMOBILE OPTS FOR DIESEL POWER	HS-021 610

<b>ORGANIZED</b>	DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]	HS-021 572	HS-78-02
<b>OVERVIEW</b>	INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CON- CEPT GENERATION AND ANALYSIS. FINAL REPORT	HS-021 485	HS-802 672
	OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEH- ICLES	HS-021 538	HS-802 673
	OVERVIEW OF THE REPORT OF THE FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980	HS-021 549	HS-802 674
	TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS: AN OVERVIEW OF FINAL RESULTS	HS-021 602	HS-802 675
<b>OWNED</b>	CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER- OWNED, CATALYST-EQUIPPED VEHICLES	HS-021 525	HS-802 676
<b>PANEL</b>	THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"	HS-021 596	HS-802 677
<b>PARAMETER</b>	COMPUTERIZED FIVE PARAMETER ENGINE MAPPING	HS-021 533	HS-802 678
<b>PARTICIPATION</b>	PUBLIC PARTICIPATION IN TRANSPORTATION PLANNING	HS-021 478	HS-802 679
<b>PARTICULATES</b>	TRAPPING OF LEAD PARTICULATES IN AUTOMO- TIVE EXHAUST	HS-021 522	HS-802 680
<b>PARTS</b>	ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION	HS-021 562	HS-802 681
	EVALUATION OF TEST DUMMY'S FLESH PARTS PRODUCED WITH SUBSTITUTE FOAMING COM- POUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER TO 30 SEPTEMBER 1977	HS-802 709	HS-802 682
<b>PASSENGER</b>	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 11, 3 MAY 1976 TO 6 JUNE 1976	HS-802 671	HS-802 683
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 12, 7 JUNE 1976 TO 6 JULY 1976		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 13, 5 JULY 1976 TO 8 AUGUST 1976		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AU- GUST 1976 TO 12 SEPTEMBER 1976		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 15, 13 SEPTEMBER 1976 TO 10 OCTOBER 1976		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 16, 11 OCTOBER 1976 TO 7 NOVEMBER 1976		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 17, 8 NOVEMBER 1976 TO 5 DECEMBER 1976		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 18, 6 DECEMBER 1976 TO 9 JANUARY 1977		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 19, 10 JANUARY 1977 TO 13 FEBRUARY 1977		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 20, 14 FEBRUARY 1977 TO 13 MARCH 1977		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 21, 14 MARCH 1977 TO 10 APRIL 1977		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 22, 11 APRIL 1977 TO 1 MAY 1977		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 23, 2 MAY 1977 TO 5 JUNE 1977		
	DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT		

february 28, 1978

SEAT PASSENGER. PROGRESS REPORT NO. 24, 6 JUNE 1977 TO 10 JULY 1977

HS-802 684

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 25, 11 JULY 1977 TO 14 AUGUST 1977

HS-802 685

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED

HS-802 686

INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]

HS-021 579

MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?

HS-020 722

#### PASSIVE

PASSIVE SEAT BELT STUDY. MONTHLY PROGRESS REPORT NO. 2

HS-802 687

STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?

HS-021 536

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 691

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 692

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 693

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 694

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 695

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER

HS-802 696

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER

HS-802 697

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 698

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 699

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 700

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 701

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 702

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 703

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 704

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON

HS-802 705

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT

HS-802 706

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 707

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT

HS-802 708

#### PATROL

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3)

HS-802 717

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3)

HS-802 719

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)

HS-802 724

#### PEDESTRIAN

YOUNG PEDESTRIAN BEHAVIOR

HS-021 473

#### PEDIATRIC

PEDIATRIC ROAD ACCIDENTS

HS-021 580

HSL 78-02

<b>PERCHLORATE</b> SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS	HS-021 528	<b>POLICY</b> SYMPOSIUM ON CURRENT ISSUES IN TRANSPORTATION POLICY	HS-021 495
<b>PERFORMANCE</b> CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE	HS-021 557	<b>POST</b> ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE	HS-021 550
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-021 556	INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS	HS-021 556
THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING-RELATED SKILLS PERFORMANCE	HS-020 726	OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 538
<b>PERIOD</b> MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?	HS-021 588	THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553
<b>PERSPECTIVE</b> INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS	HS-020 722	<b>POTENTIAL</b> ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605
<b>PETROLEUM</b> MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?	HS-020 722	ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 606
<b>PHYSICIAN</b> DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY	HS-021 575	<b>POWER</b> OLDSMOBILE OPTS FOR DIESEL POWER	HS-021 610
<b>PLANNING</b> INVOLVING CITIZENS IN METROPOLITAN REGION TRANSPORTATION PLANNING. 1977 FINAL REPORT	HS-021 498	<b>PRACTICAL</b> ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC	HS-021 561
PUBLIC PARTICIPATION IN TRANSPORTATION PLANNING	HS-021 478	<b>PREDICT</b> FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472
<b>PLATINUM</b> IMMUNOLOGICAL STUDIES ON PLATINUM COMPLEXES AND THEIR POSSIBLE RELEVANCE TO AUTOCATALYSTS	HS-021 524	<b>PREDICTING</b> VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS	HS-020 916
<b>PLUS</b> THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"	HS-021 596	<b>PRESENTATION</b> THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"	HS-021 596
<b>POLICIES</b> ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT	HS-021 470		

February 28, 1978

<b>PRESIDENT</b> REPORT TO THE PRESIDENT ON COMPLIANCE WITH THE 55 MPH SPEED LIMIT	HS-021 502	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY AL- COHOL. ANNUAL REPORT NO. 3 (PT. 8) HS-802 730
<b>PREVENTION</b> LOSS PREVENTION: THE CONSUMER'S AND THE INDUSTRY'S RESPONSIBILITIES	HS-810 308	<b>PROGNOSIS</b> CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF AL- LEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S HS-021 541
<b>PRICES</b> TRAVEL BEHAVIOR UNDER INCREASES IN GASOLINE PRICES	HS-021 474	<b>PROJECT</b> APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY AC- TION PROJECT. ANNUAL REPORT] HS-802 725
<b>PRINCIPLES</b> THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLI- MENTING COMPLETE AND COST EFFECTIVE VEHIC- LE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS	HS-021 554	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3) HS-802 717
<b>PRIORITY</b> PROGRAM PRIORITY AND LIMITATION ANALYSIS. FINAL REPORT	HS-802 320	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3) HS-802 719
<b>PROBLEMS</b> ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARAC- TERISTICS OF THE PUBLIC	HS-021 561	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5) HS-802 720
MEDICAL REPORTING OF DRIVERS WITH EMO- TIONAL PROBLEMS	HS-021 576	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3) HS-802 724
<b>PROCEEDINGS</b> AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CON- FERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977	HS-021 568	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1) HS-802 726
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINIS- TRATION, TRUCK AND BUS SAFETY SUBCOMMIT- TEES. TRANSCRIPT OF PROCEEDINGS, WINSTON- SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977	HS-802 689	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EF- FORTS. ANNUAL REPORT NO. 3 (PT. 6) HS-802 729
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINIS- TRATION, TRUCK AND BUS SAFETY SUBCOMMIT- TEES. TRANSCRIPT OF PROCEEDINGS, WINSTON- SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977	HS-802 690	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY HS-802 728
<b>PRODUCED</b> EVALUATION OF TEST DUMMY'S FLESH PARTS PRODUCED WITH SUBSTITUTE FOAMING COM- POUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER TO 30 SEPTEMBER 1977	HS-802 709	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY AL- COHOL. ANNUAL REPORT NO. 3 (PT. 8) HS-802 730
<b>PROFILE</b> A PROFILE OF FATAL ACCIDENTS INVOLVING AL- COHOL	HS-021 586	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7) HS-802 727
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY HS-802 716
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY HS-802 718
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY HS-802 722

		HSL 78-02
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY	HS-802 723	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY	HS-802 731	HS-020 916
KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 1, JANUARY 1-DECEMBER 31, 1972	HS-802 715	HS-021 591
KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 3, JANUARY 1-DECEMBER 31, 1974	HS-802 721	HS-021 500
<b>PROPAGATION</b> VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE	HS-021 466	
<b>PROTECTION</b> EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED	HS-802 686	HS-021 485
EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567	HS-021 486
<b>PROVIDED</b> FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472	
<b>PUBLIC</b> ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC	HS-021 561	HS-021 577
CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS	HS-021 471	
HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976	HS-021 496	HS-021 573
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7)	HS-802 727	
PUBLIC ATTITUDES ON RESTRAINT SYSTEMS: AN ANNOTATED BIBLIOGRAPHY	HS-021 493	HS-020 720
PUBLIC PARTICIPATION IN TRANSPORTATION PLANNING	HS-021 478	HS-021 498
<b>REGISTRATION</b> FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES		HS-020 978
<b>REHABILITATION</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT NO. 3 (PT. 6)		HS-020 979

february 28, 1978

**REINFORCEMENT**

THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY

HS-021 578

**RELATING**

ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC

HS-021 561

**RELEVANCE**

IMMUNOLOGICAL STUDIES ON PLATINUM COMPLEXES AND THEIR POSSIBLE RELEVANCE TO AUTOCATALYSTS

HS-021 524

**RELEVANT**

FIELD RELEVANT TESTS: OUR MOST IMPORTANT MOTOR VEHICLE GOAL

HS-021 560

**REPAIR**

AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS

HS-021 563

**REPEAL**

IMPACT OF MOTORCYCLE HELMET LAW REPEAL

HS-021 569

**REQUEST**

GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY

HS-021 483

**RESEARCH**

A DECADE OF RESEARCH IN VEHICLE REAR LIGHTING: WHAT HAVE WE LEARNED?

HS-021 577

**RESPONDING**

HABIT CHECK OF SEEING AND RESPONDING IN DRIVING

HS-021 477

**RESPONSE**

ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT

HS-021 470

GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY

HS-021 483

TRANSIENT RESPONSE OF A CARBURETOR ENGINE

HS-021 467

**RESPONSIBILITIES**

LOSS PREVENTION: THE CONSUMER'S AND THE INDUSTRY'S RESPONSIBILITIES

HS-810 308

**RESPONSIBILITY**

DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY

HS-021 575

**RESTRAINED**

INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]

HS-021 579

**RESTRAINT**

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED

HS-802 686

PUBLIC ATTITUDES ON RESTRAINT SYSTEMS: AN ANNOTATED BIBLIOGRAPHY

HS-021 493

STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?

HS-021 536

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 691

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 692

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 693

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 694

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 695

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER

HS-802 696

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER

HS-802 697

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 698

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 699

	HSL 78-02
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT	
	HS-802 700
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT	
	HS-802 701
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT	
	HS-802 702
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT	
	HS-802 703
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT	
	HS-802 704
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON	
	HS-802 705
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT	
	HS-802 706
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON	
	HS-802 707
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT	
	HS-802 708
<b>RESTRUCTURING</b>	
FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES	
	HS-020 978
<b>RESULTS</b>	
EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS	
	HS-021 523
FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NA- TIONAL ASSOCIATION OF FLEET ADMINIS- TATORS, INC.	
	HS-021 540
THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND AP- PROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS	
	HS-021 520
TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS: AN OVERVIEW OF FINAL RESULTS	
	HS-021 602
<b>RETARDERS</b>	
VEHICLE RETARDERS: PRESENT AND FUTURE	
	HS-021 542
<b>REVIEW</b>	
A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIO- GRAPHY. FINAL REPORT	
	HS-021 492
<b>RIDE</b>	
TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM	
	HS-021 469
<b>RIDERS</b>	
INJURY CHARACTERISTICS OF RIDERS OF MOTOR- CYCLES, MINIBIKES, AND MOPEDS	
	HS-021 594
<b>RIGHT</b>	
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT	
	HS-802 700
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT	
	HS-802 702
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT	
	HS-802 704
<b>ROAD</b>	
A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION	
	HS-021 537
<b>PEDIATRIC ROAD ACCIDENTS</b>	
	HS-021 580
ROAD INJURIES IN QUEBEC [CANADA] (1974): NA- TURE, SEVERITY AND DIRECT COSTS	
	HS-021 591
<b>ROADSIDE</b>	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY	
	HS-802 723
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY	
	HS-802 731
ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN CANADA	
	HS-021 589
<b>ROADWAY</b>	
INVESTIGATING THE ROADWAY ENVIRONMENT	
	HS-021 595
<b>ROLLOVER</b>	
MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES	
	HS-802 303
<b>RSV</b>	
MINICARS RSV BRAKE SYSTEM	
	HS-021 535

february 28, 1978

**RURAL**

A METHOD FOR THE COMPREHENSIVE RECORDING  
AND ANALYSIS OF THE EFFECTIVENESS OF AN  
EMERGENCY MEDICAL SYSTEM IN AN URBAN AND  
RURAL AREA

HS-021 573

**SAFEST**

THE SAFEST WAY TO CRASH...DON'T. AN EX-  
AMINATION OF EMERGENCY BRAKING  
TECHNIQUES

HS-021 481

**SALEM**

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINIS-  
TRATION, TRUCK AND BUS SAFETY SUBCOMMIT-  
TEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-  
SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER  
19, 1977

HS-802 689

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINIS-  
TRATION, TRUCK AND BUS SAFETY SUBCOMMIT-  
TEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-  
SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER  
20, 1977

HS-802 690

**SAMPLING**

THE NATIONAL ACCIDENT SAMPLING SYSTEM - A  
STATUS REPORT

HS-021 604

**SATISFACTION**

CONSUMER SATISFACTION WITH THE EXTENT OF  
GOVERNMENTAL INDUCED VEHICLE SAFETY  
DESIGN AS INDICATED BY JUDGES AND JURORS IN  
TORT LITIGATION DECISIONS ARISING OUT OF AL-  
LEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE  
1980'S

HS-021 541

**SCHOOL**

MULTIDISCIPLINARY ACCIDENT INVESTIGATION:  
FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS  
ROLLOVER; 29 FATALITIES

HS-802 303

**SCHOOLBUS**

A STUDY OF SOME SCHOOLBUS CRASHES

HS-021 585

**SCI**

MECHANISMS OF SPINAL CORD INJURY (SCI) IN  
VEHICLE OCCUPANTS

HS-021 593

**SCREENING**

EVALUATION OF SULFATE TRAPPING CANDI-  
DATES--RESULTS FROM DYNAMOMETER AND  
VEHICLE SCREENING TESTS

HS-021 523

ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN  
CANADA

HS-021 589

**SEAT**

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT

SEAT PASSENGER. PROGRESS REPORT NO. 11, 3  
MAY 1976 TO 6 JUNE 1976

HS-802 671

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 12, 7  
JUNE 1976 TO 6 JULY 1976

HS-802 672

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 13, 5  
JULY 1976 TO 8 AUGUST 1976

HS-802 673

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AU-  
GUST 1976 TO 12 SEPTEMBER 1976

HS-802 674

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 15, 13  
SEPTEMBER 1976 TO 10 OCTOBER 1976

HS-802 675

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 16, 11  
OCTOBER 1976 TO 7 NOVEMBER 1976

HS-802 676

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 17, 8  
NOVEMBER 1976 TO 5 DECEMBER 1976

HS-802 677

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 18, 6  
DECEMBER 1976 TO 9 JANUARY 1977

HS-802 678

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 19, 10  
JANUARY 1977 TO 13 FEBRUARY 1977

HS-802 679

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 20, 14  
FEBRUARY 1977 TO 13 MARCH 1977

HS-802 680

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 21, 14  
MARCH 1977 TO 10 APRIL 1977

HS-802 681

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 22, 11  
APRIL 1977 TO 1 MAY 1977

HS-802 682

DEVELOPMENT OF THE ASPIRATION INFLATION  
TECHNIQUE FOR SUBCOMPACT CARS - FRONT  
SEAT PASSENGER. PROGRESS REPORT NO. 23, 2  
MAY 1977 TO 5 JUNE 1977

HS-802 683

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 24, 6 JUNE 1977 TO 10 JULY 1977	HS-802 684	THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY	HS-021 578
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 25, 11 JULY 1977 TO 14 AUGUST 1977	HS-802 685	THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY	HS-021 579
PASSIVE SEAT BELT STUDY. MONTHLY PROGRESS REPORT NO. 2	HS-802 685	KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES	HS-021 578
	HS-802 687	THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY	HS-021 579
<b>SECRETARY</b>		<b>SIGNAL</b>	
HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976	HS-021 496	DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT	HS-021 491
<b>SEEING</b>		<b>SIMULATION</b>	
HABIT CHECK OF SEEING AND RESPONDING IN DRIVING	HS-021 477	A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES	HS-021 517
<b>SELECTION</b>		COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS	HS-021 518
SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT	HS-021 497	FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472
<b>SERVICE</b>		INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM	HS-021 494
EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE	HS-021 552	SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM	HS-021 516
<b>SERVICES</b>		VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION	HS-021 521
DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]	HS-021 572	<b>SINGLE</b>	
EMERGENCY MEDICAL SERVICES	HS-021 597	KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES	HS-021 519
FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES	HS-020 978	STEADY TURNING OF SINGLE-TRACK VEHICLES	HS-021 520
<b>SEVERE</b>		<b>SINGLY</b>	
SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT	HS-021 497	THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING-RELATED SKILLS PERFORMANCE	HS-021 588
<b>SEVERITY</b>		<b>SKILLS</b>	
A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT	HS-021 492	THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING-RELATED SKILLS PERFORMANCE	HS-021 588
COLLISION SEVERITY - MEASURED BY (DELTA)V	HS-021 601	<b>SLIP</b>	
ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS	HS-021 591	KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES	HS-021 519

february 28, 1978

**SMALL**

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 691

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 692

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 693

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 694

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 695

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER

HS-802 696

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER

HS-802 697

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 698

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 699

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 700

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 701

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 702

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 703

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 704

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON

HS-802 705

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT

HS-802 706

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 707

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT

HS-802 708

**SOCIETY**

THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY)

HS-021 551

**SODIUM**

USE OF SODIUM AZIDE FOR AIR CUSHION INFLATOR

HS-021 484

**SOUTHWESTERN**

ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]

HS-021 584

**SPARK**

VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE

HS-021 466

**SPECIAL**

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3)

HS-802 717

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3)

HS-802 719

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)

HS-802 724

**SPECIES**

THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY

HS-021 526

**SPECTROMETRY**

THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY

HS-021 526

**SPEED**

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED

HS-802 686

REPORT TO THE PRESIDENT ON COMPLIANCE WITH THE 55 MPH SPEED LIMIT	HS-021 502	HSL 78-02
1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4	HS-021 504	PROPRIETENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS
1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B	HS-021 505	HS-802 302
1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C	HS-021 506	STATIC
1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D	HS-021 507	NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS
1976 VEHICLE LOW SPEED IMPACT TESTING: EVALUATION IN THE CONTEXT OF FMVSS 215	HS-021 508	HS-021 515
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4	HS-021 509	STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B	HS-021 510	HS-021 536
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C	HS-021 511	STATISTICS
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D	HS-021 512	HIGHWAY STATISTICS. SUMMARY TO 1975
<b>SPEEDOMETERS</b>		HS-021 609
TESTING OF VEHICLE SPEEDOMETERS AND ODOMETERS FOR ACCURACY. FINAL REPORT	HS-802 713	WHEN STATISTICS AREN'T QUITE NORMAL
<b>SPINAL</b>		HS-021 500
MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS	HS-021 593	STEADY
<b>SQUEEZE</b>		STEADY TURNING OF SINGLE-TRACK VEHICLES
UNDERSTANDING ENGINES. SUCK, SQUEEZE, POP, PHOOEY	HS-021 513	HS-021 520
<b>STANDARDS</b>		STRATIFICATION
DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT	HS-021 491	EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION
INCOMPATIBLE STANDARDS AND THEIR IMPLICATIONS FOR AUTOMOTIVE MEDICINE	HS-021 603	HS-021 468
THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS	HS-021 554	<b>STREETS</b>
THE IMPORTANCE OF AUTOMOTIVE FUEL ECONOMY STANDARDS	HS-021 546	IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS
THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND AP-		HS-021 476
		<b>STRUCTURE</b>
		FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES
		HS-020 978
		<b>STUDDED</b>
		STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS
		HS-021 490
		<b>SUBCOMMITTEES</b>
		NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977
		HS-802 689
		NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977
		HS-802 690
		<b>SUBCOMPACT</b>
		DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 11, 3 MAY 1976 TO 6 JUNE 1976
		HS-802 671

february 28, 1978

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 12, 7 JUNE 1976 TO 6 JULY 1976

HS-802 672

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 13, 5 JULY 1976 TO 8 AUGUST 1976

HS-802 673

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AUGUST 1976 TO 12 SEPTEMBER 1976

HS-802 674

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 15, 13 SEPTEMBER 1976 TO 10 OCTOBER 1976

HS-802 675

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 16, 11 OCTOBER 1976 TO 7 NOVEMBER 1976

HS-802 676

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 17, 8 NOVEMBER 1976 TO 5 DECEMBER 1976

HS-802 677

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 18, 6 DECEMBER 1976 TO 9 JANUARY 1977

HS-802 678

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 19, 10 JANUARY 1977 TO 13 FEBRUARY 1977

HS-802 679

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 20, 14 FEBRUARY 1977 TO 13 MARCH 1977

HS-802 680

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 21, 14 MARCH 1977 TO 10 APRIL 1977

HS-802 681

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 22, 11 APRIL 1977 TO 1 MAY 1977

HS-802 682

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 23, 2 MAY 1977 TO 5 JUNE 1977

HS-802 683

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT

SEAT PASSENGER. PROGRESS REPORT NO. 24, 6 JUNE 1977 TO 10 JULY 1977

HS-802 684

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 25, 11 JULY 1977 TO 14 AUGUST 1977

HS-802 685

#### SUBSTITUTE

EVALUATION OF TEST DUMMY'S FLESH PARTS PRODUCED WITH SUBSTITUTE FOAMING COMPOUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER TO 30 SEPTEMBER 1977

HS-802 709

#### SULFATE

CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES

HS-021 525

EVALUATION OF SULFATE TRAPPING CANDIDATES-RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS

HS-021 523

SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS

HS-021 528

THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY

HS-021 526

#### SUPPLY

TRAFFIC AS A FUNCTION OF SUPPLY AND DEMAND

HS-021 475

#### SURVEY

FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.

HS-021 540

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY

HS-802 728

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 716

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 718

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 722

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY

HS-802 723

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY

HS-802 731

THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND AP-

PROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS	HS-802 302	HSL 78-02
<b>SUSPENSION</b>		
SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM	HS-021 486	
<b>SUSPENSIONS</b>		
NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS	HS-021 728	
<b>SYMPORIUM</b>		
SYMPORIUM ON CURRENT ISSUES IN TRANSPORTATION POLICY	HS-020 916	
<b>TABLES</b>		
APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT]	HS-021 537	
<b>TARGET</b>		
THE TARGET CAR PROGRAM FOR 1977	HS-021 686	
<b>TASK</b>		
OVERVIEW OF THE REPORT OF THE FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980	HS-021 709	
<b>TAXICAB</b>		
TAXICAB OPERATING CHARACTERISTICS. FINAL REPORT	HS-021 691	
<b>TEAMSTERS</b>		
THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 692	
<b>TECHNOLOGY</b>		
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 693	
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 694	
INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT	HS-021 695	
	HS-021 696	
	HS-021 697	
	HS-021 698	

february 28, 1978

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 699

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT  
HS-802 700

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT  
HS-802 701

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT  
HS-802 702

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT  
HS-802 703

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT  
HS-802 704

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON  
HS-802 705

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT  
HS-802 706

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 707

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT  
HS-802 708

#### TESTING

TESTING OF VEHICLE SPEEDOMETERS AND  
ODOMETERS FOR ACCURACY. FINAL REPORT  
HS-802 713

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1  
OF 4  
HS-021 504

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2  
OF 4. APPENDIX B  
HS-021 505

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3  
OF 4. APPENDIX C  
HS-021 506

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4  
OF 4. APPENDIX D  
HS-021 507

1976 VEHICLE LOW SPEED IMPACT TESTING:  
EVALUATION IN THE CONTEXT OF FMVSS 215  
HS-021 508

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1  
OF 4  
HS-021 509

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2  
OF 4. APPENDIX B  
HS-021 510

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3  
OF 4. APPENDIX C  
HS-021 511

1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4  
OF 4. APPENDIX D  
HS-021 512

#### TESTS

DEVELOPMENT OF STANDARDS AND TESTS FOR  
ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL  
REPORT  
HS-021 491

EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND  
VEHICLE SCREENING TESTS  
HS-021 523

FIELD RELEVANT TESTS: OUR MOST IMPORTANT  
MOTOR VEHICLE GOAL  
HS-021 560

#### THINGS

THE BETTER THINGS IN LIFE ARE NOT FREE  
HS-021 558

#### THOUGHTS

TODAY'S THOUGHTS ON TOMORROW'S TRUCKS  
HS-021 547

#### TIRE

DEVELOPMENT OF GLASS FIBER TIRE CORD  
HS-021 499

#### TIRES

STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS  
HS-021 490

#### TITLE

HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION  
(7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR  
YEAR 1976  
HS-021 496

#### TITRATION

SULFATE ANALYSIS BY THE BARIUM  
PERCHLORATE TITRATION AND THE BCA  
METHODS  
HS-021 528

#### TOMORROW

FLEET VEHICLES TODAY AND TOMORROW. THE  
RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL  
ASSOCIATION OF FLEET ADMINISTRATORS, INC.  
HS-021 540

TODAY'S THOUGHTS ON TOMORROW'S TRUCKS  
HS-021 547

#### TORT

CONSUMER SATISFACTION WITH THE EXTENT OF  
GOVERNMENTAL INDUCED VEHICLE SAFETY  
DESIGN AS INDICATED BY JUDGES AND JURORS IN  
TORT LITIGATION DECISIONS ARISING OUT OF AL-

LEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S	HS-021 541	HSL 78-02
TOYOTA TOYOTA'S LIGHT-WEIGHT ELASTOMER BUMPER	HS-021 544	TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS: AN OVERVIEW OF FINAL RESULTS HS-021 602
TRACK KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES	HS-021 519	TRANSBUS A TRANSIT OPERATOR VIEWS TRANSBUS HS-021 543
STEADY TURNING OF SINGLE-TRACK VEHICLES	HS-021 520	TRANSCRIPT NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977 HS-802 689
TRACKED TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM	HS-021 469	NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977 HS-802 690
TRADE ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION	HS-021 562	TRANSIENT TRANSIENT RESPONSE OF A CARBURETOR ENGINE HS-021 467
TRAFFIC ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605	TRANSIT A TRANSIT OPERATOR VIEWS TRANSBUS HS-021 543
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 606	IMPROVEMENTS IN THE SAFETY OF URBAN TRANSIT COACHES HS-021 564
BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587	TRANSPORTATION ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE HS-021 550
DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT	HS-021 491	GENERAL MOTORS CORPORATION RESPONSE TO THE DEPARTMENT OF TRANSPORTATION REQUEST FOR INFORMATION ON THE EVALUATION OF THE HYBRID III DUMMY HS-021 483
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977	HS-802 689	HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976 HS-021 496
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977	HS-802 690	INVOLVING CITIZENS IN METROPOLITAN REGION TRANSPORTATION PLANNING. 1977 FINAL REPORT HS-021 498
SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT	HS-021 497	PUBLIC PARTICIPATION IN TRANSPORTATION PLANNING HS-021 478
TRAFFIC AS A FUNCTION OF SUPPLY AND DEMAND	HS-021 475	SYMPOSIUM ON CURRENT ISSUES IN TRANSPORTATION POLICY HS-021 495
		TRAPPING EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS HS-021 523
		TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST HS-021 522

february 28, 1978

**TRAVEL**

TRAVEL BEHAVIOR UNDER INCREASES IN GASOLINE PRICES

HS-021 474

**TRUCK**

FATALLY INJURED TRUCK DRIVERS

HS-021 600

INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS

HS-021 556

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977

HS-802 689

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977

HS-802 690

**TRUCKING**

DRIVER CONTROL IN THE TRUCKING INDUSTRY

HS-021 582

**TRUCKS**

DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980

HS-021 539

GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE

HS-021 583

TODAY'S THOUGHTS ON TOMORROW'S TRUCKS

HS-021 547

**TUESDAY**

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977

HS-802 690

**TURBOCHARGED**

EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION

HS-021 468

**TURBULENT**

VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE

HS-021 466

**TURNING**

STEADY TURNING OF SINGLE-TRACK VEHICLES

HS-021 520

**TYPE**

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRON-

TAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED

HS-802 686

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 691

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 692

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 693

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 694

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET

HS-802 695

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER

HS-802 696

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER

HS-802 697

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 698

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON

HS-802 699

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 700

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 701

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 702

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT

HS-802 703

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT

HS-802 704

VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON

HS-802 705

HSL 78-02

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT  
HS-802 706

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON  
HS-802 707

VEHICLE INTEGRATION AND EVALUATION OF  
PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST  
REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT  
HS-802 708

#### ULTIMATE

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE  
PERFORMANCE MEASURES. ANNUAL REPORT NO. 3  
(PT. 1)

HS-802 726

#### UNDERGOING

DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL  
VEHICLE MODEL UNDERGOING LARGE DEFLEC-  
TIONS

HS-021 514

#### UNIQUE

A DEGREE PROGRAM FOR EMS ADMINISTRATORS -  
A UNIQUE APPROACH

HS-021 574

#### UPDATING

FEES STRUCTURE OF THE DEPARTMENT OF MOTOR  
VEHICLES. A STUDY OF ALTERNATIVES FOR  
RESTRUCTURING AND UPDATING FEES CHARGED  
FOR REGISTRATION, LICENSING, AND RELATED  
SERVICES

HS-020 978

#### URBAN

A METHOD FOR THE COMPREHENSIVE RECORDING  
AND ANALYSIS OF THE EFFECTIVENESS OF AN  
EMERGENCY MEDICAL SYSTEM IN AN URBAN AND  
RURAL AREA

HS-021 573

ENERGY CONSUMPTION IN URBAN TRANSPORTA-  
TION: THE ROLE OF THE POST-1980 AUTOMOBILE  
HS-021 550

IMPROVEMENTS IN THE SAFETY OF URBAN  
TRANSIT COACHES

HS-021 564

#### URGENT

CONVINCING THE PUBLIC TO BUY THE MORE  
FUEL-EFFICIENT CARS: AN URGENT NATIONAL  
NEED. REPORT TO THE CONGRESS

HS-021 471

#### USER

A TECHNIQUE FOR MEASUREMENT OF DELAY AT  
INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL  
REPORT

HS-021 608

#### UTILIZATION

MAXIMIZING PETROLEUM UTILIZATION THROUGH  
EXTENSION OF PASSENGER CAR OIL DRAIN  
PERIOD -- WHAT'S REQUIRED?

HS-020 722

#### VALIDATION

VALIDATION OF A TURBULENT FLAME PROPAGA-  
TION MODEL FOR A SPARK IGNITION ENGINE  
HS-021 466

VALIDATION OF HUMAN BODY MODELING FOR  
DYNAMIC SIMULATION  
HS-021 521

#### VALIUM

THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY  
AND IN COMBINATION, UPON DRIVING-RELATED  
SKILLS PERFORMANCE  
HS-021 588

#### VANCOUVER

AMERICAN ASSOCIATION FOR AUTOMOTIVE  
MEDICINE. PROCEEDINGS OF THE 21ST CON-  
FERENCE, VANCOUVER, BRITISH COLUMBIA  
[CANADA], SEPTEMBER 15-17, 1977  
HS-021 568

#### VEHICLE

A DECADE OF RESEARCH IN VEHICLE REAR  
LIGHTING: WHAT HAVE WE LEARNED?  
HS-021 577

A ROAD TEST CONCEPT FOR DYNAMIC MOTOR  
VEHICLE DIAGNOSTIC EVALUATION  
HS-021 537

ALICE IN THE WONDERLAND OF MOTOR VEHICLE  
SAFETY - CONCEPTUAL AND PRACTICAL  
PROBLEMS IN RELATING HIGHWAY AND MOTOR  
VEHICLE SAFETY PROGRAMS TO CHARAC-  
TERISTICS OF THE PUBLIC  
HS-021 561

ASSESSMENT OF THE APPLICATION OF AUTO-  
MATIC VEHICLE IDENTIFICATION TECHNOLOGY  
TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUA-  
TION OF POTENTIAL APPLICATIONS OF AUTO-  
MATIC VEHICLE IDENTIFICATION TO TRAFFIC  
MANAGEMENT. FINAL REPORT  
HS-021 605

ASSESSMENT OF THE APPLICATION OF AUTO-  
MATIC VEHICLE IDENTIFICATION TECHNOLOGY  
TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUA-  
TION OF POTENTIAL APPLICATIONS OF AUTO-  
MATIC VEHICLE MONITORING TO TRAFFIC  
MANAGEMENT. FINAL REPORT  
HS-021 606

CONSUMER SATISFACTION WITH THE EXTENT OF  
GOVERNMENTAL INDUCED VEHICLE SAFETY  
DESIGN AS INDICATED BY JUDGES AND JURORS IN  
TORT LITIGATION DECISIONS ARISING OUT OF AL-  
LEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE  
1980'S  
HS-021 541

CUSTOMER MAINTENANCE HABITS AND THEIR  
AWARENESS OF VEHICLE PERFORMANCE  
HS-021 557

DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL  
VEHICLE MODEL UNDERGOING LARGE DEFLEC-  
TIONS  
HS-021 514

ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED  
MOTOR VEHICLE ACCIDENT DATA BASE FOR  
SOUTHWESTERN ONTARIO [CANADA]  
HS-021 584

february 28, 1978

EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS	HS-021 523	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER	HS-802 697
FIELD RELEVANT TESTS: OUR MOST IMPORTANT MOTOR VEHICLE GOAL	HS-021 560	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 698
INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]	HS-021 579	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 699
MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS	HS-021 593	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 700
OVERVIEW OF THE REPORT OF THE FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980	HS-021 549	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT	HS-802 701
SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM	HS-021 516	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 702
TESTING OF VEHICLE SPEEDOMETERS AND ODOMETERS FOR ACCURACY. FINAL REPORT	HS-802 713	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT	HS-802 703
THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS	HS-021 554	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT	HS-802 704
THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"	HS-021 596	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON	HS-802 705
TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM	HS-021 469	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT	HS-802 706
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 691	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 707
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 692	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT	HS-802 708
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-802 693	VEHICLE RETARDERS: PRESENT AND FUTURE	HS-021 542
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET	HS-802 694	VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA	HS-021 555
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET	HS-802 695	1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4	HS-021 504
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER	HS-802 696	1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B	HS-021 505
		1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C	HS-021 506

## HSL 78-02

1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D	HS-021 507	THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES	HS-021 565
1976 VEHICLE LOW SPEED IMPACT TESTING: EVALUATION IN THE CONTEXT OF FMVSS 215	HS-021 508	VIABILITY	VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4	HS-021 509		HS-021 555
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 2 OF 4. APPENDIX B	HS-021 510	VIEWS	A TRANSIT OPERATOR VIEWS TRANSBUS
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 3 OF 4. APPENDIX C	HS-021 511		HS-021 543
1977 VEHICLE LOW SPEED IMPACT TESTING. VOL. 4 OF 4. APPENDIX D	HS-021 512	THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553
<b>VEHICLES</b>		<b>VILLAGE</b>	SAFETY VILLAGE CONCEPT
A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES	HS-021 517		HS-021 581
CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES	HS-021 525	<b>VISCOMETER</b>	VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS
COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS	HS-021 548		HS-020 916
EMISSIONS FROM IN-USE CATALYST VEHICLES	HS-021 527	<b>VISIBILITY</b>	FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT
FEES STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED FOR REGISTRATION, LICENSING, AND RELATED SERVICES	HS-020 978		HS-021 472
FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.	HS-021 540	<b>WARNING</b>	INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT
INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS	HS-021 556		HS-021 485
KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES	HS-021 519	INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT	HS-021 486
OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 538	<b>WAY</b>	THE SAFEST WAY TO CRASH...DON'T. AN EXAMINATION OF EMERGENCY BRAKING TECHNIQUES
STEADY TURNING OF SINGLE-TRACK VEHICLES	HS-021 520		HS-021 481
THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553	<b>WEATHER</b>	SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT
			HS-021 497
		<b>WEIGHT</b>	EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE
			HS-021 552
		TOYOTA'S LIGHT-WEIGHT ELASTOMER BUMPER	NO-DAMAGE
			HS-021 544
		<b>WHEEL</b>	FRONT-WHEEL DRIVE
			HS-021 479

february 28, 1978

THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES

HS-021 553

**WINSTON**

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, MONDAY, SEPTEMBER 19, 1977

HS-802 689

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRUCK AND BUS SAFETY SUBCOMMITTEES. TRANSCRIPT OF PROCEEDINGS, WINSTON-SALEM, NORTH CAROLINA, TUESDAY, SEPTEMBER 20, 1977

HS-802 690

**WONDERLAND**

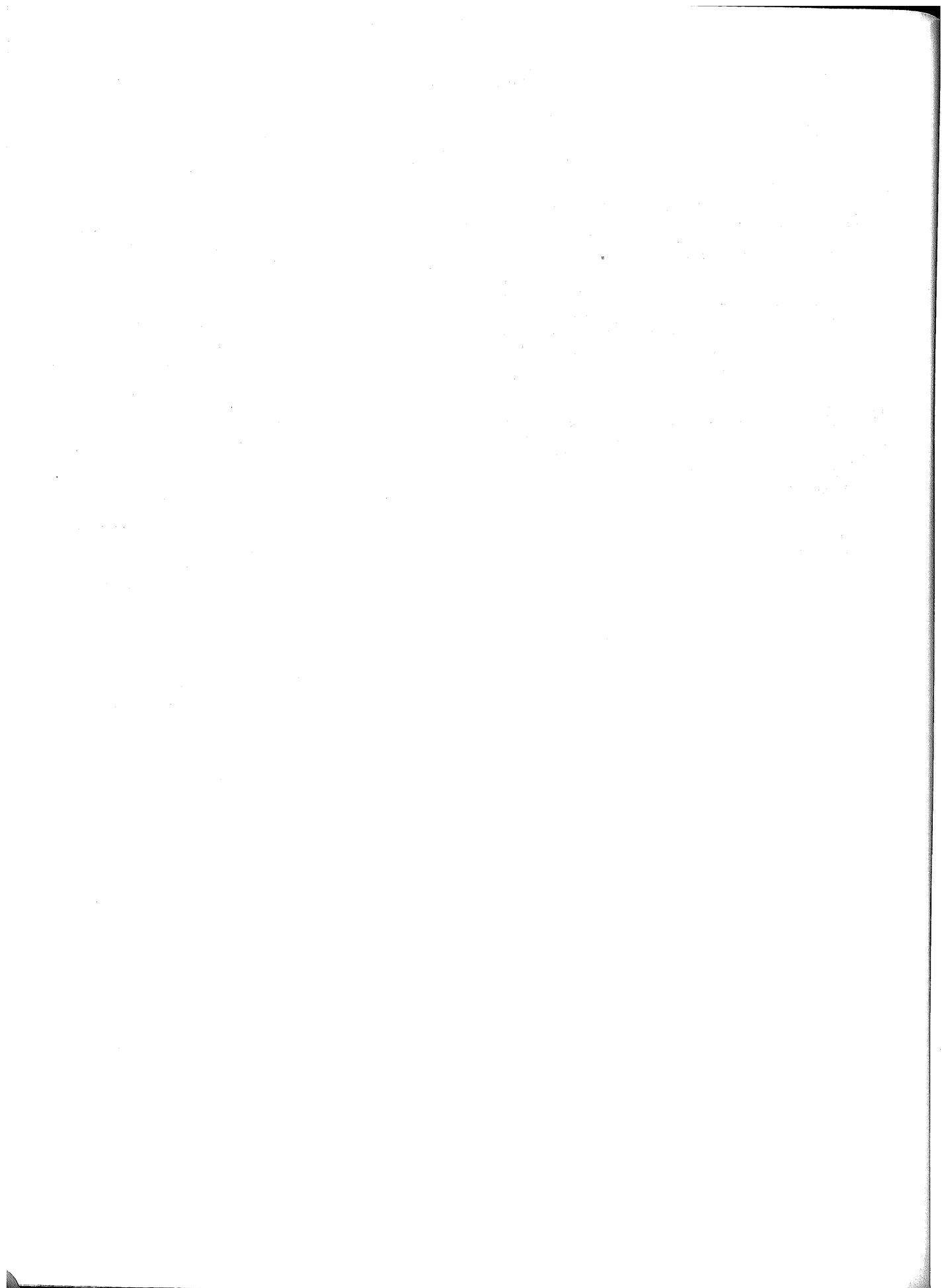
ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC

HS-021 561

**YOUNG**

YOUNG PEDESTRIAN BEHAVIOR

HS-021 473



## Author Index

**van Thiel, M.**  
COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS  
HS-021 518

**Aaron, R.**  
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT  
HS-021 605

ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT  
HS-021 606

**Adams, Brock**  
REPORT TO THE PRESIDENT ON COMPLIANCE WITH THE 55 MPH SPEED LIMIT  
HS-021 502

**Adil, Anees A.**  
THE IMPORTANCE OF AUTOMOTIVE FUEL ECONOMY STANDARDS  
HS-021 546

**Ahlers, C. T. J.**  
DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980  
HS-021 539

**Ailsby, R. L.**  
A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA  
HS-021 573

**Alexander, D. L.**  
VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS  
HS-020 916

**Angell, J. C.**  
INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM  
HS-021 494

**Auiler, J. E.**  
OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS  
HS-021 530

**Averett,**  
MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES  
HS-802 303

**Ayers, J. A.**  
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS  
HS-021 529

**Baird,**  
MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES  
HS-802 303

**Baker, L. L.**  
THE BETTER THINGS IN LIFE ARE NOT FREE  
HS-021 558

**Baker, R. E.**  
ENGINE MAPPING METHODOLOGY  
HS-021 531

**Baker, Susan P.**  
FATALLY INJURED TRUCK DRIVERS  
HS-021 600

**Balcerak, John C.**  
INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS  
HS-021 594

**Barber, Dennis R.**  
DEVELOPMENT OF GLASS FIBER TIRE CORD  
HS-021 499

**Barker, Colin**  
SAFETY VILLAGE CONCEPT  
HS-021 581

**Barnes, G. J.**  
EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS  
HS-021 523

**Bayazitoglu, Y. O.**  
DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS  
HS-021 514

**Bayer, Anthony R.**  
TESTING OF VEHICLE SPEEDOMETERS AND ODOMETERS FOR ACCURACY. FINAL REPORT  
HS-802 713

**Becker, J. M.**  
VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION  
HS-021 521

**Becker, Judith M.**  
FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT  
HS-021 472

**Beckley, Addison S.**  
THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHIC

HSL 78-02

CLE CRASHWORTHINESS AND OCCUPANT SAFETY  
STANDARDS

HS-021 554

**Beitel, George A.**

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 716

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY  
PATROL. ANNUAL REPORT NO. 1 (PT. 3)

HS-802 717

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 718

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY  
PATROL. ANNUAL REPORT NO. 2 (PT. 3)

HS-802 719

**Bennett, R. O.**

VALIDATION OF HUMAN BODY MODELING FOR  
DYNAMIC SIMULATION

HS-021 521

**Berke, Robert J. , comp.**

FLEET VEHICLES TODAY AND TOMORROW. THE  
RESULTS OF A SURVEY CONDUCTED BY THE NA-  
TIONAL ASSOCIATION OF FLEET ADMINIS-  
TRATORS, INC.

HS-021 540

**Bintz, Louis J.**

THE TARGET CAR PROGRAM FOR 1977

HS-021 545

**Blackbourne, B. D.**

THE ROLE OF THE MEDICAL EXAMINER IN CRASH  
INVESTIGATION

HS-021 598

**Bloom, G. M.**

VEHICLE RETARDERS: PRESENT AND FUTURE

HS-021 542

**Blumberg, P. N.**

OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRA-  
TION FOR BETTER FUEL ECONOMY--METHODS  
AND APPLICATIONS

HS-021 530

**Bode, J. J.**

SELECTION OF TRAFFIC CONTROLS FOR SEVERE  
WEATHER CONDITIONS. FINAL REPORT

HS-021 497

**Bourbeau, R. R.**

ROAD INJURIES IN QUEBEC [CANADA] (1974): NA-  
TURE, SEVERITY AND DIRECT COSTS

HS-021 591

**Bowthorpe, W. D.**

ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN  
CANADA

HS-021 589

**Boyer, D. S.**

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR  
RAILROAD-HIGHWAY GRADE CROSSING MOTORIST

WARNING SYSTEMS. VOL. 2. THE GENERATION  
AND ANALYSIS OF ALTERNATIVE CONCEPTS.  
FINAL REPORT

HS-021 486

**Bradow, R. L.**

CHARACTERIZATION OF SULFATE AND GASEOUS  
EMISSIONS FROM CALIFORNIA CONSUMER-  
OWNED, CATALYST-EQUIPPED VEHICLES

HS-021 525

**Brooker, M. C.**

INNOVATIVE CONCEPTS AND TECHNOLOGY FOR  
RAILROAD-HIGHWAY GRADE CROSSING MOTORIST  
WARNING SYSTEMS. VOL. 1. OVERVIEW AND CON-  
CEPT GENERATION AND ANALYSIS. FINAL REPORT

HS-021 485

**Burns, M.**

THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY  
AND IN COMBINATION, UPON DRIVING-RELATED  
SKILLS PERFORMANCE

HS-021 588

**Byer, S.**

EMISSIONS FROM IN-USE CATALYST VEHICLES

HS-021 527

**Campbell, Kenneth L.**

A REVIEW AND INVESTIGATION OF BETTER CRASH  
SEVERITY MEASURES: AN ANNOTATED BIBLIO-  
GRAPHY. FINAL REPORT

HS-021 492

**Carlson, R. R.**

CHARACTERIZATION OF SULFATE AND GASEOUS  
EMISSIONS FROM CALIFORNIA CONSUMER-  
OWNED, CATALYST-EQUIPPED VEHICLES

HS-021 525

**Carmichael, Gil**

THE ETHICAL CAR EVOLVED (KEY TO A CHANG-  
ING SOCIETY)

HS-021 551

**Casassa, James , 2nd.**

AUTOMOBILE CRASH DAMAGE: USE OF REPAIR IN-  
FORMATION FOR EVALUATING AUTOMOBILE  
DESIGN CHARACTERISTICS

HS-021 563

**Cassidy, John F.**

A COMPUTERIZED ON-LINE APPROACH TO CALCUL-  
ATING OPTIMUM ENGINE CALIBRATIONS

HS-021 532

**Chace, M. A.**

DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL  
VEHICLE MODEL UNDERGOING LARGE DEFLEC-  
TIONS

HS-021 514

INTERACTIVE SIMULATION OF MACHINERY WITH  
FRICTION AND IMPACT USING DRAM

HS-021 494

SIMULATION OF A VEHICLE SUSPENSION WITH  
THE ADAMS COMPUTER PROGRAM

HS-021 516

february 28, 1978

<b>Claybrook, Joan</b>	LOSS PREVENTION: THE CONSUMER'S AND THE INDUSTRY'S RESPONSIBILITIES	HS-810 308	COHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT	HS-021 470
	WHAT COMES NEXT IN AUTO SAFETY?	HS-021 534	Dunlap, D. F.	
<b>Cleare, M. J.</b>	IMMUNOLOGICAL STUDIES ON PLATINUM COMPLEXES AND THEIR POSSIBLE RELEVANCE TO AUTOCATALYSTS	HS-021 524	STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS	HS-021 490
<b>Close, W. H.</b>	OVERVIEW OF THE REPORT OF THE FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980	HS-021 549	Durbin, Enoch J.	
<b>Cochran, C. N.</b>	ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION	HS-021 562	TRANSIENT RESPONSE OF A CARBURETOR ENGINE	HS-021 467
<b>Collard, D.</b>	BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587	Durham, R. V.	
<b>Corsi, Thomas M.</b>	TRAVEL BEHAVIOR UNDER INCREASES IN GASOLINE PRICES	HS-021 474	THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553
<b>Creswell, J. S.</b>	STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS	HS-021 490	Fell, James C.	
<b>Cummings, John J.</b>	HABIT CHECK OF SEEING AND RESPONDING IN DRIVING	HS-021 477	A PROFILE OF FATAL ACCIDENTS INVOLVING ALCOHOL	HS-021 586
<b>Daby, E. E.</b>	ENGINE MAPPING METHODOLOGY	HS-021 531	THE NATIONAL ACCIDENT SAMPLING SYSTEM - A STATUS REPORT	HS-021 604
<b>Davis, Merritt M.</b>	A STUDY OF SOME SCHOOLBUS CRASHES	HS-021 585	Ferlis, R. A.	
<b>Deen, Robert C.</b>	IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS	HS-021 476	ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605
<b>Dennis, M. E.</b>	ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS	HS-021 590	ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 606
<b>Doban, Robert C.</b>	DEVELOPMENT OF GLASS FIBER TIRE CORD	HS-021 499	Foley, James P.	
<b>Douglass, Richard L.</b>	ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE AL-		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-802 720
			KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 722
			KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY	HS-802 723
			KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)	HS-802 724
			KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-802 726

HSL 78-02

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF ALCOHOL REHABILITATION EF-  
FORTS. ANNUAL REPORT NO. 3 (PT. 6)

HS-802 729

**Fredericks, D. R.**

EVALUATION OF SULFATE TRAPPING CANDI-  
DATES-RESULTS FROM DYNAMOMETER AND  
VEHICLE SCREENING TESTS

HS-021 523

**Freedman, A.**

STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL.  
1. DESCRIPTION. FINAL REPORT

HS-021 487

STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL.  
2. ANALYSIS. FINAL REPORT

HS-021 488

**Freedman, Jay Alan**

ALCOHOL-RELATED CASUALTIES AND ALCOHOL  
BEVERAGE MARKET RESPONSE TO BEVERAGE AL-  
COHOL AVAILABILITY POLICIES IN MICHIGAN.  
VOL. 1. FINAL TECHNICAL REPORT

HS-021 470

**Fuller, Don**

UNDERSTANDING ENGINES. SUCK, SQUEEZE, POP,  
PHOOEY

HS-021 513

**Gafford, R. D.**

CHARACTERIZATION OF SULFATE AND GASEOUS  
EMISSIONS FROM CALIFORNIA CONSUMER-  
OWNED, CATALYST-EQUIPPED VEHICLES

HS-021 525

**Gardner, C. C.**

A TECHNIQUE FOR MEASUREMENT OF DELAY AT  
INTERSECTIONS. VOL. 1. TECHNICAL REPORT.  
FINAL REPORT

HS-021 607

A TECHNIQUE FOR MEASUREMENT OF DELAY AT  
INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL  
REPORT

HS-021 608

**Gardner, Richard E.**

AUTOMOBILE CRASH DAMAGE: USE OF REPAIR IN-  
FORMATION FOR EVALUATING AUTOMOBILE  
DESIGN CHARACTERISTICS

HS-021 563

**Gergel, W. C.**

MAXIMIZING PETROLEUM UTILIZATION THROUGH  
EXTENSION OF PASSENGER CAR OIL DRAIN  
PERIOD -- WHAT'S REQUIRED?

HS-020 722

**Gibbs, R.**

EMISSIONS FROM IN-USE CATALYST VEHICLES

HS-021 527

**Glauz, William D.**

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 716

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY  
PATROL. ANNUAL REPORT NO. 1 (PT. 3)

HS-802 717

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 718

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY  
PATROL. ANNUAL REPORT NO. 2 (PT. 3)

HS-802 719

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF DRINKER DIAGNOSIS AND  
REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT.  
5)

HS-802 720

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY

HS-802 722

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1974 ROADSIDE SURVEY

HS-802 723

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY  
PATROL. ANNUAL REPORT NO. 3 (PT. 3)

HS-802 724

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE  
PERFORMANCE MEASURES. ANNUAL REPORT NO. 3  
(PT. 1)

HS-802 726

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
PUBLIC INFORMATION AND EDUCATION. ANNUAL  
REPORT NO. 3 (PT. 7)

HS-802 727

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
ANALYSIS OF FIRST TELEPHONE SURVEY

HS-802 728

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
AN ANALYSIS OF ALCOHOL REHABILITATION EF-  
FORTS. ANNUAL REPORT NO. 3 (PT. 6)

HS-802 729

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
PROFILE STUDIES OF DRIVERS IMPAIRED BY AL-  
COHOL. ANNUAL REPORT NO. 3 (PT. 8)

HS-802 730

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT.  
1975 ROADSIDE SURVEY

HS-802 731

**Goodson, R. Eugene**

BALANCING MOBILITY, SAFETY, ENVIRONMENT,  
ENERGY USE, AND ECONOMICS FOR AUTOMO-  
BILES

HS-021 559

**Green, J. A.**

STUDDED TIRES AND HIGHWAY SAFETY. FEASI-  
BILITY OF DETERMINING INDIRECT BENEFITS

HS-021 490

February 28, 1978

**Green, R. N.**  
ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA] HS-021 584

**INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]** HS-021 579

**Green, Robert N.**  
THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE HS-021 599

**Grey, Anthony**  
ELASTOMERIC USE IN 1978 AUTOS HS-021 501

**Griffin, Lindsay I., 3rd.**  
THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW HS-021 570

**Grimm, Ann C.**  
PUBLIC ATTITUDES ON RESTRAINT SYSTEMS: AN ANNOTATED BIBLIOGRAPHY HS-021 493

**Griskivich, Peter**  
INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS HS-021 556

**Gruber, G. J.**  
GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE HS-021 583

**Haas, Gary**  
PROGRAM PRIORITY AND LIMITATION ANALYSIS. FINAL REPORT HS-020 320

**Hamilton, S. C.**  
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS HS-021 529

**Harvey, Milton E.**  
TRAVEL BEHAVIOR UNDER INCREASES IN GASOLINE PRICES HS-021 474

**Harvey, T. M.**  
THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY HS-021 526

**Heiges, Harvey E.**  
ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE HS-021 550

**Heikes, Russell G.**  
WHEN STATISTICS AREN'T QUITE NORMAL HS-021 500

**Herling, R. J.**  
CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES HS-021 525

**Hill, B.**  
EMISSIONS FROM IN-USE CATALYST VEHICLES HS-021 527

**Huelke, Donald F., ed.**  
AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CONFERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977 HS-021 568

**Hughes,**  
MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES HS-802 303

**Inglis, F. G.**  
A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA HS-021 573

**Innes, Joseph J.**  
VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA HS-021 555

**Jeya, P.**  
SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT HS-021 497

**Johnson, R.**  
EMISSIONS FROM IN-USE CATALYST VEHICLES HS-021 527

**Joksch, Hans. C.**  
PROGRAM PRIORITY AND LIMITATION ANALYSIS. FINAL REPORT HS-802 320

**Jones, Ian S.**  
THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY HS-021 578

**Kahane, Charles J.**  
THE NATIONAL ACCIDENT SAMPLING SYSTEM - A STATUS REPORT HS-021 604

**Kane, Thomas R.**  
KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES HS-021 519

STEADY TURNING OF SINGLE-TRACK VEHICLES HS-021 520

**Karlson, Trudy A.**  
FATALLY INJURED TRUCK DRIVERS HS-021 600

**Kauffman, C. W.**  
VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE  
HS-021 466

**Keane, M. A.**  
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS  
HS-021 529

**Kell, J. H.**  
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 1. TECHNICAL REPORT. FINAL REPORT  
HS-021 607

A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT  
HS-021 608

**Kern, Paul J.**  
EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION  
HS-021 468

**Kibbee, Lewis C.**  
TODAY'S THOUGHTS ON TOMORROW'S TRUCKS  
HS-021 547

**King, David F.**  
DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT  
HS-021 491

**Kirkbride, Russell L.**  
TESTING OF VEHICLE SPEEDOMETERS AND ODOMETERS FOR ACCURACY. FINAL REPORT  
HS-802 713

**Koropey, Oleh B.**  
EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION  
HS-021 468

**Laberge-Nadeau, C.**  
ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS  
HS-021 591

**Lavoie, G. A.**  
VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE  
HS-021 466

**Little, Joseph W.**  
CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S  
HS-021 541

**Lummis, Michael**  
IMPACT OF MOTORCYCLE HELMET LAW REPEAL  
HS-021 569

**Lyles, A.**  
CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES  
HS-021 525

**Marple, G. A.**  
STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 1. DESCRIPTION. FINAL REPORT  
HS-021 487

STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 2. ANALYSIS. FINAL REPORT  
HS-021 488

**Marquardt, James F.**  
COLLISION SEVERITY - MEASURED BY (DELTA)V  
HS-021 601

**Marsh, Joseph C. , 4th**  
A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT  
HS-021 492

**Martin, David E.**  
FIELD RELEVANT TESTS: OUR MOST IMPORTANT MOTOR VEHICLE GOAL  
HS-021 560

**Massing, Daniel E.**  
EVALUATION OF TEST DUMMY'S FLESH PARTS PRODUCED WITH SUBSTITUTE FOAMING COMPOUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER TO 30 SEPTEMBER 1977  
HS-802 709

**McCuiston, F. D. , Jr.**  
VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE  
HS-021 466

**McDonald, John W.**  
THE TARGET CAR PROGRAM FOR 1977  
HS-021 545

**McIvor, Ivor K.**  
A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES  
HS-021 517

**McPherson, Duncan**  
MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS  
HS-021 593

**McSwain, Norman E. , Jr.**  
A DEGREE PROGRAM FOR EMS ADMINISTRATORS - A UNIQUE APPROACH  
HS-021 574

EMERGENCY MEDICAL SERVICES  
HS-021 597

IMPACT OF MOTORCYCLE HELMET LAW REPEAL  
HS-021 569

**Metcalf, E. I.**  
STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 1. DESCRIPTION. FINAL REPORT  
HS-021 487

february 28, 1978

STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 2. ANALYSIS. FINAL REPORT	HS-021 488	Nomura, Takao TOYOTA'S LIGHT-WEIGHT ELASTOMER BUMPER	NO-DAMAGE
<b>Mohney, F. W.</b> VEHICLE RETARDERS: PRESENT AND FUTURE	HS-021 542		HS-021 544
<b>Moran, B.</b> COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS	HS-021 518		HS-021 479
<b>Moran, Rosemary</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY	HS-802 728		HS-021 518
<b>Morman, Kenneth N. , Jr.</b> NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS	HS-021 515		HS-021 584
<b>Morris, Robert L.</b> TRAFFIC AS A FUNCTION OF SUPPLY AND DEMAND	HS-021 475	ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]	HS-021 579
<b>Mortimer, R. G.</b> A DECADE OF RESEARCH IN VEHICLE REAR LIGHTING: WHAT HAVE WE LEARNED?	HS-021 577	INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]	HS-021 516
<b>Mortimer, Rudolf G.</b> FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472		HS-021 554
<b>Morton, A. S.</b> STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 1. DESCRIPTION. FINAL REPORT	HS-021 487		HS-021 587
<b>Morton, A. S.</b> STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 2. ANALYSIS. FINAL REPORT	HS-021 488		
<b>Morton, Bert F.</b> FATALLY INJURED TRUCK DRIVERS	HS-021 600		
<b>Moskowitz, H.</b> THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING-RELATED SKILLS PERFORMANCE	HS-021 588		
<b>Nagel, Donald A.</b> DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?	HS-021 592		HS-021 486
<b>Nichols, Robert</b> THE SAFEST WAY TO CRASH...DON'T. AN EXAMINATION OF EMERGENCY BRAKING TECHNIQUES	HS-021 481		HS-021 589
<b>Picton, W. R.</b> ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN CANADA			HS-021 480
<b>Poon, S. Y.</b> EVALUATION OF A HUB ASSEMBLY			

HSL 78-02

<b>Prostak, Arnold</b> SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS	HS-021 528	<b>Rourke, R. J.</b> SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT	HS-021 497
<b>Raab, F. H.</b> INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT	HS-021 485	<b>Ryan, T. E.</b> INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT	HS-021 485
<b>Rabe, F. T.</b> DYNAMIC MODELS OF THE U.S. AUTOMOBILE FLEET. FINAL REPORT	HS-021 489	<b>Salter, Richard G.</b> A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION	HS-021 537
<b>Ransford, P. M.</b> DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]	HS-021 572	<b>Schmidt, R.</b> COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS	HS-021 548
<b>Reed, Martin H.</b> PEDIATRIC ROAD ACCIDENTS	HS-021 580	<b>Schuetzle, D.</b> THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY	HS-021 526
<b>Reidy, Joseph C. , Jr.</b> PROGRAM PRIORITY AND LIMITATION ANALYSIS. FINAL REPORT	HS-020 320	<b>Seiff, Henry E.</b> OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 538
<b>Reilly, W. R.</b> A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 1. TECHNICAL REPORT. FINAL REPORT	HS-021 607	<b>Shah, Upendra</b> A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT	HS-021 492
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT	HS-021 608	<b>Sharp, Michael C.</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-020 726
<b>Rein, S. W.</b> VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS	HS-020 916	<b>Sharp, Michael C.</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-020 716
<b>Reisinger, Keith S.</b> EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-020 718
<b>Reiss, Martin L.</b> YOUNG PEDESTRIAN BEHAVIOR	HS-021 473	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-020 720
<b>Rishavy, E. A.</b> ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS	HS-021 529	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-020 722
<b>Robbins, D. H.</b> VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION	HS-021 521	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY	HS-020 731

february 28, 1978

<b>Sharpe, Gilbert S.</b> DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY	HS-021 575	
<b>Sheahan, T. J.</b> MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?	HS-020 722	HS-021 523
<b>Simanaitis, Dennis J.</b> OLDSMOBILE OPTS FOR DIESEL POWER	HS-021 610	HS-021 467
<b>Simpson, H. M.</b> BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587	HS-021 582
<b>Simpson, John</b> MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS	HS-021 593	HS-021 557
<b>Skelton, Mary Beth</b> A DEGREE PROGRAM FOR EMS ADMINISTRATORS - A UNIQUE APPROACH	HS-021 574	HS-021 584
<b>Smith, Russell A.</b> THE NATIONAL ACCIDENT SAMPLING SYSTEM - A STATUS REPORT	HS-021 604	HS-021 579
<b>Sorenson, Wayne</b> AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS	HS-021 563	HS-021 602
<b>States, John D.</b> DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?	HS-021 592	HS-021 522
<b>VanWagoner, Wayne T.</b> INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS	HS-021 594	HS-021 595
<b>Ventre, Philippe</b> STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?	HS-021 536	HS-021 552
<b>Strong, S. T.</b> THE VEHICLE-PRESENTATION "INVESTIGATION PLUS ACTION"	HS-021 596	HS-021 533
<b>Sublett,</b> MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES	HS-802 303	HS-021 485
<b>Summers, J. C.</b> EVALUATION OF SULFATE TRAPPING CANDIDATES-RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS		HS-021 566
<b>Tanaka, Munenobu</b> TRANSIENT RESPONSE OF A CARBURETOR ENGINE		
<b>Taylor, R. C.</b> DRIVER CONTROL IN THE TRUCKING INDUSTRY		
<b>Teasel, Richard C.</b> CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE		
<b>Thomas, L. S.</b> ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]		
<b>Treat, John R.</b> INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]		
<b>Treuhart, Martin B.</b> TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST		
<b>Vander Bok, A. J.</b> DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980		
<b>VanWagoner, Wayne T.</b> INVESTIGATING THE ROADWAY ENVIRONMENT		
<b>Ventre, Philippe</b> EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE		
<b>Vora, Lakshmi S.</b> COMPUTERIZED FIVE PARAMETER ENGINE MAPPING		
<b>Waechter, J. R.</b> INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CONCEPT GENERATION AND ANALYSIS. FINAL REPORT		
<b>Wakeland, Henry H.</b> ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT		

INCOMPATIBLE STANDARDS AND THEIR IMPLICATIONS FOR AUTOMOTIVE MEDICINE HS-021 603

Waller, Julian A. ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC HS-021 561

Waller, Patricia F. THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW HS-021 570

Walsh, Michael J. EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED HS-021 686

Walsh, Michael P. THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES HS-021 565

Warren, R. A. BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES HS-021 587

Wellman, Barry PUBLIC PARTICIPATION IN TRANSPORTATION PLANNING HS-021 478

Weltman, W. C. , Jr. ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION HS-021 562

Werner, P. EMISSIONS FROM IN-USE CATALYST VEHICLES HS-021 527

Weygandt, James L. MEDICAL REPORTING OF DRIVERS WITH EMOTIONAL PROBLEMS HS-021 576

Wheeler, Paul TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM HS-021 469

Whitten, Charles A TRANSIT OPERATOR VIEWS TRANSBUS HS-021 543

Wiedemann, B. COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS HS-021 548

Williams, Allan F. EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS HS-021 567

Williams, S. G. EVALUATION OF A HUB ASSEMBLY HS-021 480

Wing, John F. IMPROVEMENTS IN THE SAFETY OF URBAN TRANSIT COACHES HS-021 564

Wisnewski, John P. TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST HS-021 522

Wotzak, G. EMISSIONS FROM IN-USE CATALYST VEHICLES HS-021 527

Zbrozek, J. D. OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY-METHODS AND APPLICATIONS HS-021 530

Zegeer, Charles V. IDENTIFICATION OF HAZARDOUS LOCATIONS ON CITY STREETS HS-021 476

## Corporate Author Index

**Aluminum Co. of America** ALUMINUM CAR PARTS, THE NO TRADE-OFF SAFETY OPTION HS-021 562

**American Assoc. for Automotive Medicine, P.O. Box 222, Morton Grove, Ill. 60053** AMERICAN ASSOCIATION FOR AUTOMOTIVE MEDICINE. PROCEEDINGS OF THE 21ST CONFERENCE, VANCOUVER, BRITISH COLUMBIA [CANADA], SEPTEMBER 15-17, 1977 HS-021 568

**American Trucking Assoc., Inc.** TODAY'S THOUGHTS ON TOMORROW'S TRUCKS HS-021 547

**Ann Arbor Testing Labs., Inc., P.O. Box 2078, Ann Arbor, Mich. 48106** DEVELOPMENT OF STANDARDS AND TESTS FOR ACCEPTANCE OF TRAFFIC SIGNAL LENSES. FINAL REPORT HS-021 491

**Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140** STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 1. DESCRIPTION. FINAL REPORT HS-021 487

STUDY OF AUTOMOBILE MARKET DYNAMICS. VOL. 2. ANALYSIS. FINAL REPORT HS-021 488

**Arthur Young and Co., 1025 Connecticut Ave., Washington, D.C. 20036** SELECTION OF TRAFFIC CONTROLS FOR SEVERE WEATHER CONDITIONS. FINAL REPORT HS-021 497

**Automobile Club of Southern California** THE TARGET CAR PROGRAM FOR 1977 HS-021 545

**Automobile Safety Corp.** THE ESSENTIAL PRINCIPLES INVOLVED IN IMPLEMENTING COMPLETE AND COST EFFECTIVE VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY STANDARDS HS-021 554

**Booz, Allen and Hamilton Inc.** IMPROVEMENTS IN THE SAFETY OF URBAN TRANSIT COACHES HS-021 564

**Brown and Root, Inc.** DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS HS-021 514

**California Dept. of Motor Vehicles, Office of Prog. Devel. and Evaluation, Sacramento, Calif.** FEE STRUCTURE OF THE DEPARTMENT OF MOTOR VEHICLES. A STUDY OF ALTERNATIVES FOR RESTRUCTURING AND UPDATING FEES CHARGED

FOR REGISTRATION, LICENSING, AND RELATED SERVICES HS-020 978

**Calspan Corp., Buffalo, N.Y. 14221** DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 18, 6 DECEMBER 1976 TO 9 JANUARY 1977 HS-802 678

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 19, 10 JANUARY 1977 TO 13 FEBRUARY 1977 HS-802 679

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 20, 14 FEBRUARY 1977 TO 13 MARCH 1977 HS-802 680

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 21, 14 MARCH 1977 TO 10 APRIL 1977 HS-802 681

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 22, 11 APRIL 1977 TO 1 MAY 1977 HS-802 682

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 23, 2 MAY 1977 TO 5 JUNE 1977 HS-802 683

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 24, 6 JUNE 1977 TO 10 JULY 1977 HS-802 684

DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 25, 11 JULY 1977 TO 14 AUGUST 1977 HS-802 685

EVALUATION OF OCCUPANT PROTECTION DEVICES AND RESTRAINT SYSTEMS. TEST REPORT. TEST NO.: 353 - CALMAN 19. TYPE OF TEST: FRONTAL - CAR-TO-CAR OFFSET PASSENGER TO PASSENGER 60 MPH CLOSING SPEED HS-802 686

**Calspan Corp., Buffalo, N.Y. 14221** EVALUATION OF TEST DUMMY'S FLESH PARTS PRODUCED WITH SUBSTITUTE FOAMING COMPOUNDS. PROGRESS REPORT NO. 7, 1 SEPTEMBER TO 30 SEPTEMBER 1977 HS-802 709

**Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221** DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT

SEAT PASSENGER. PROGRESS REPORT NO. 11, 3 MAY 1976 TO 6 JUNE 1976	HS-802 671	HSL 78-02
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 12, 7 JUNE 1976 TO 6 JULY 1976	HS-802 672	CUSTOMER MAINTENANCE HABITS AND THEIR AWARENESS OF VEHICLE PERFORMANCE HS-021 557
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 13, 5 JULY 1976 TO 8 AUGUST 1976	HS-802 673	Children's Hospital of Pittsburgh, Pa. EVALUATION OF THREE EDUCATIONAL PRO- GRAMS DESIGNED TO INCREASE THE CRASH PRO- TECTION OF INFANTS IN CARS HS-021 567
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 14, 9 AU- GUST 1976 TO 12 SEPTEMBER 1976	HS-802 674	Chrysler Corp. THE BETTER THINGS IN LIFE ARE NOT FREE HS-021 558
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 15, 13 SEPTEMBER 1976 TO 10 OCTOBER 1976	HS-802 674	TRACKED VEHICLE RIDE DYNAMICS COMPUTER PROGRAM HS-021 469
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 16, 11 OCTOBER 1976 TO 7 NOVEMBER 1976	HS-802 675	Cincinnati Electronics Corp., 2630 Glendale Rd., Cincinnati, Ohio 45241 INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 1. OVERVIEW AND CON- CEPT GENERATION AND ANALYSIS. FINAL REPORT HS-021 485
DEVELOPMENT OF THE ASPIRATION INFLATION TECHNIQUE FOR SUBCOMPACT CARS - FRONT SEAT PASSENGER. PROGRESS REPORT NO. 17, 8 NOVEMBER 1976 TO 5 DECEMBER 1976	HS-802 676	City of Kansas City, Mo. KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY HS-802 716
Calspan Field Services, Inc., Accident Res. Div., Buffalo, N.Y. 14221 THE EFFECT OF SIDE DOOR REINFORCEMENT BEAMS AND 5 MPH ENERGY ABSORBING BUMPERS ON INJURY SEVERITY	HS-802 677	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3) HS-802 717
Capital Region Safety Council, Victoria, B.C., Canada SAFETY VILLAGE CONCEPT	HS-802 581	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY HS-802 718
Casciato, White and Associates, Toronto, Ont., Canada ASSESSMENT OF THE APPLICATION OF AUTO- MATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALU- ATION OF POTENTIAL APPLICATIONS OF AUTO- MATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-802 605	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 5) HS-802 719
ASSESSMENT OF THE APPLICATION OF AUTO- MATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALU- ATION OF POTENTIAL APPLICATIONS OF AUTO- MATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-802 606	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY HS-802 720
Center for Environment and Man, Inc., 275 Windsor St., Hartford, Conn. 06120 PROGRAM PRIORITY AND LIMITATION ANALYSIS. FINAL REPORT	HS-802 320	KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3) HS-802 721
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1) HS-802 722
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7) HS-802 723
		HS-802 724
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1) HS-802 725
		KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7) HS-802 726
		HS-802 727

february 28, 1978

KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY	HS-802 728	Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT NO. 3 (PT. 6)	HS-802 729	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 1. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 691
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY ALCOHOL. ANNUAL REPORT NO. 3 (PT. 8)	HS-802 729	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 2. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 692
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY	HS-802 730	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 3. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 693
Comptroller General of the United States, Washington, D.C. 20548	HS-802 731	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 4. TEST TYPE: CAR-TO-CAR OFFSET HS-802 694
CONVINCING THE PUBLIC TO BUY THE MORE FUEL-EFFICIENT CARS: AN URGENT NATIONAL NEED. REPORT TO THE CONGRESS	HS-021 471	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 5. TEST TYPE: CAR-TO-CAR OFFSET HS-802 695
Consolidated Freightways, Menlo Park, Calif. DRIVER CONTROL IN THE TRUCKING INDUSTRY	HS-021 582	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 6. TEST TYPE: CAR-TO-BARRIER HS-802 696
Control Data Corp., 6003 Executive Blvd., Rockville, Md. 20852		VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 7. TEST TYPE: CAR-TO-BARRIER HS-802 697
TAXICAB OPERATING CHARACTERISTICS. FINAL REPORT	HS-021 482	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 8. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 698
Cummins Engine Co., Inc. DIESEL ENGINES FOR HEAVY DUTY TRUCKS BEYOND 1980	HS-021 539	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 9. TEST TYPE: CAR-TO-CAR HEAD-ON HS-802 699
Deere and Co. SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM	HS-021 516	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 10. TEST TYPE: CAR-TO-CAR 30° RIGHT HS-802 700
Department of Transportation HAZARDOUS MATERIALS CONTROL. ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION (7TH). HAZARDOUS MATERIALS TRANSPORTATION ACT (TITLE I, PUBLIC LAW 93-633). CALENDAR YEAR 1976	HS-021 496	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 11. TEST TYPE: CAR-TO-CAR 30° LEFT HS-802 701
Department of Transportation, Motor Vehicle Goals Task Force OVERVIEW OF THE REPORT OF THE FEDERAL TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980	HS-021 549	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 12. TEST TYPE: CAR-TO-CAR 30° RIGHT HS-802 702
Department of Transportation, Voluntary Truck and Bus Fuel Economy Prog. OVERVIEW OF THE INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 538	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 13. TEST TYPE: CAR-TO-CAR 30° LEFT HS-802 703
Dept. of Transportation, Washington, D.C. 20590 REPORT TO THE PRESIDENT ON COMPLIANCE WITH THE 55 MPH SPEED LIMIT	HS-021 502	VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 14. TEST TYPE: CAR-TO-CAR 30° RIGHT HS-802 704
		VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 15. TEST TYPE: CAR-TO-CAR HEAD ON HS-802 705

HSL 78-02	
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 16. TEST TYPE: CAR-TO-CAR 45° LEFT	HS-021 505
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 17. TEST TYPE: CAR-TO-CAR HEAD-ON	HS-021 506
VEHICLE INTEGRATION AND EVALUATION OF PASSIVE SMALL CAR RESTRAINT SYSTEM. TEST REPORT 18. TEST TYPE: CAR-TO-CAR OFFSET LEFT	HS-021 507
Engineering and Technical Service Div. THE TARGET CAR PROGRAM FOR 1977	HS-021 508
Environmental Impact Center, Inc., 55 Chapel St., Newton, Mass. 02158	HS-021 509
DYNAMIC MODELS OF THE U.S. AUTOMOBILE FLEET. FINAL REPORT	HS-021 510
Environmental Protection Agency	HS-021 511
CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES	HS-021 512
Environmental Protection Agency, Technical Support Branch	HS-021 523
THE NEED FOR AND BENEFITS OF INSPECTION AND MAINTENANCE OF IN-USE MOTOR VEHICLES	HS-021 524
Federal Hwy. Administration, Hwy. Statistics Div., Washington, D.C.	HS-021 483
HIGHWAY STATISTICS. SUMMARY TO 1975	HS-021 484
Ford Motor Co.	HS-021 529
NON-LINEAR MODEL FORMULATION FOR THE STATIC AND DYNAMIC ANALYSES OF FRONT SUSPENSIONS	HS-021 530
THE MOLECULAR ANALYSIS OF SULFATE SPECIES IN ENVIRONMENTAL AEROSOLS USING CHEMICAL IONIZATION MASS SPECTROMETRY	HS-021 531
Ford Motor Co., Engineering and Res. Staff	HS-021 532
ENGINE MAPPING METHODOLOGY	HS-021 533
OPTIMIZATION OF AUTOMOTIVE ENGINE CALIBRATION FOR BETTER FUEL ECONOMY--METHODS AND APPLICATIONS	HS-021 534
Ford Motor Co., Fuels and Lubricants Dept.	HS-021 535
VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE	HS-021 536
General Environments Corp., Hartwood, Va. 22471	HS-021 537
1976 VEHICLE LOW SPEED IMPACT TESTING. VOL. 1 OF 4	HS-021 538
General Motors Corp.	HS-021 539
EVALUATION OF SULFATE TRAPPING CANDIDATES--RESULTS FROM DYNAMOMETER AND VEHICLE SCREENING TESTS	HS-021 540
General Motors Corp., Chevrolet Engineering	HS-021 541
ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS	HS-021 542
General Motors Corp., Environmental Activities Staff	HS-021 543
FIELD RELEVANT TESTS: OUR MOST IMPORTANT MOTOR VEHICLE GOAL	HS-021 544
General Motors Corp., General Motors Res. Labs.	HS-021 545
A COMPUTERIZED ON-LINE APPROACH TO CALCULATING OPTIMUM ENGINE CALIBRATIONS	HS-021 546
COMPUTERIZED FIVE PARAMETER ENGINE MAPPING	HS-021 547
General Motors Corp., Milford Vehicle Emission Lab.	HS-021 548
SULFATE ANALYSIS BY THE BARIUM PERCHLORATE TITRATION AND THE BCA METHODS	HS-021 549

february 28, 1978

<b>General Motors Res. Labs.</b> ENGINE CONTROL OPTIMIZATION FOR BEST FUEL ECONOMY WITH EMISSION CONSTRAINTS	HS-021 529	
<b>Health Sciences Children's Centre, Dept. of Radiology, Winnipeg, Canada</b> PEDIATRIC ROAD ACCIDENTS	HS-021 580	
<b>Indiana Univ., Inst. for Res. in Public Safety, Bloomington, Ind.</b> TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS: AN OVERVIEW OF FINAL RESULTS	HS-021 602	
<b>Insurance Corp. of British Columbia, Canada</b> MECHANISMS OF SPINAL CORD INJURY (SCI) IN VEHICLE OCCUPANTS	HS-021 593	
<b>Insurance Inst. for Hwy. Safety, Washington, D.C.</b> EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567	
<b>International Brotherhood of Teamsters, Safety and Health Dept.</b> THE HUMAN BEHIND THE WHEEL. INTERNATIONAL BROTHERHOOD OF TEAMSTERS' VIEWS ON POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES	HS-021 553	
<b>Jacobs Mfg. Co., Bloomfield, Conn.</b> VEHICLE RETARDERS: PRESENT AND FUTURE	HS-021 542	
<b>Johns Hopkins Univ., School of Public Health and Hygiene, Baltimore, Md.</b> FATALLY INJURED TRUCK DRIVERS	HS-021 600	
<b>Johnson Matthey Res. Center</b> IMMUNOLOGICAL STUDIES ON PLATINUM COMPLEXES AND THEIR POSSIBLE RELEVANCE TO AUTOCATALYSTS	HS-021 524	
<b>Joint Center for Transportation Studies</b> ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE	HS-021 550	
<b>JHK and Associates, 275 Fifth St., San Francisco, Calif. 94103</b> A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 1. TECHNICAL REPORT. FINAL REPORT	HS-021 607	
A TECHNIQUE FOR MEASUREMENT OF DELAY AT INTERSECTIONS. VOL. 3. USER'S MANUAL. FINAL REPORT	HS-021 608	
<b>Kansas City Alcohol Safety Action Proj., 414 East 12th St., Kansas City, Mo. 64106</b> KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 1, JANUARY 1-DECEMBER 31, 1972	HS-802 715	
KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT NO. 3, JANUARY 1-DECEMBER 31, 1974	HS-802 721	
APPENDIX H TABLES. JANUARY - DECEMBER, 1974 [KANSAS CITY, MISSOURI ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT]	HS-802 725	
<b>Kansas University Medical Center</b> A DEGREE PROGRAM FOR EMS ADMINISTRATORS - A UNIQUE APPROACH	HS-021 574	
<b>Lubrizol Corp.</b> MAXIMIZING PETROLEUM UTILIZATION THROUGH EXTENSION OF PASSENGER CAR OIL DRAIN PERIOD -- WHAT'S REQUIRED?	HS-020 722	
<b>Man Factors, Inc., 4433 Convoy St., Suite E, San Diego, Calif. 92111</b> PASSIVE SEAT BELT STUDY. MONTHLY PROGRESS REPORT NO. 2	HS-802 687	
<b>McMaster Univ., Faculty of Health Sciences (Canada)</b> DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY	HS-021 575	
<b>Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b> KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1972 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 716	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 1 (PT. 3)	HS-802 717	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1973 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 718	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 2 (PT. 3)	HS-802 719	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY. ANNUAL REPORT NO. 2 (PT. 5)	HS-802 720	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 HOUSEHOLD OPINION AND ATTITUDE SURVEY	HS-802 722	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1974 ROADSIDE SURVEY	HS-802 723	

HSL 78-02	
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF THE SPECIAL ALCOHOL SAFETY PATROL. ANNUAL REPORT NO. 3 (PT. 3)	HS-802 724
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF PROJECT IMPACT ON ULTIMATE PERFORMANCE MEASURES. ANNUAL REPORT NO. 3 (PT. 1)	HS-802 726
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PUBLIC INFORMATION AND EDUCATION. ANNUAL REPORT NO. 3 (PT. 7)	HS-802 728
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. ANALYSIS OF FIRST TELEPHONE SURVEY	HS-802 727
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT NO. 3 (PT. 6)	HS-802 728
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. PROFILE STUDIES OF DRIVERS IMPAIRED BY ALCOHOL. ANNUAL REPORT NO. 3 (PT. 8)	HS-802 729
KANSAS CITY ALCOHOL SAFETY ACTION PROJECT. 1975 ROADSIDE SURVEY	HS-802 730
Ministry of Health, Emergency Health Services Commission, B.C., Canada DEVELOPMENT OF A GOVERNMENT ORGANIZED EMERGENCY HEALTH SERVICES SYSTEM IN BRITISH COLUMBIA [CANADA]	HS-802 731
Motor Vehicle Manufacturers Assoc. of The United States, Inc., Motor Truck Manufacturers Div. INTERAGENCY STUDY OF POST-1980 GOALS FOR COMMERCIAL MOTOR VEHICLES FROM THE PERSPECTIVE OF TRUCK AND BUS MANUFACTURERS	HS-021 572
National Assoc. of Fleet Administrators, Inc. FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.	HS-021 576
National Hwy. Traffic Safety Administration A PROFILE OF FATAL ACCIDENTS INVOLVING ALCOHOL	HS-021 586
LOSS PREVENTION: THE CONSUMER'S AND THE INDUSTRY'S RESPONSIBILITIES	HS-810 308
THE IMPORTANCE OF AUTOMOTIVE FUEL ECONOMY STANDARDS	HS-021 546
VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA	HS-021 555
WHAT COMES NEXT IN AUTO SAFETY?	HS-021 534
National Hwy. Traffic Safety Administration, Engineering Test Facility, P.O. Box 37, East Liberty, Ohio 43319 TESTING OF VEHICLE SPEEDOMETERS AND ODOMETERS FOR ACCURACY. FINAL REPORT	HS-802 713
National Hwy. Traffic Safety Administration, National Center for Statistics and Analysis THE NATIONAL ACCIDENT SAMPLING SYSTEM - A STATUS REPORT	HS-021 604
National Motor Vehicle Safety Advisory Council THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY)	HS-021 551
National Transportation Policy Study Commission THE ETHICAL CAR EVOLVED (KEY TO A CHANGING SOCIETY)	HS-021 551
National Transportation Safety Board, Bureau of Plans and Programs ANALYSIS OF JUSTICE AND EQUITABLENESS IN THE BALANCE OF ENERGY CONSERVATION, SAFETY, AND ENVIRONMENT	HS-021 566
National Transportation Safety Board, Bureau of Plans and Programs, Washington, D.C. INCOMPATIBLE STANDARDS AND THEIR IMPLICATIONS FOR AUTOMOTIVE MEDICINE	HS-021 603
New York State Dept. of Environmental Conservation, Div. of Air Resources EMISSIONS FROM IN-USE CATALYST VEHICLES	HS-021 527
Office of the Chief Medical Examiner, Washington, D.C. THE ROLE OF THE MEDICAL EXAMINER IN CRASH INVESTIGATION	HS-021 598
Olson Labs., Inc. CHARACTERIZATION OF SULFATE AND GASEOUS EMISSIONS FROM CALIFORNIA CONSUMER-OWNED, CATALYST-EQUIPPED VEHICLES	HS-021 525
Ontario Ministry of Health DRIVING, DISEASE AND THE PHYSICIAN'S RESPONSIBILITY	HS-021 575
Parsons, Brinckerhoff, Quade and Douglas, Inc., One Penn Plaza, 250 W. 34th St., New York, N.Y. 10001 INVOLVING CITIZENS IN METROPOLITAN REGION TRANSPORTATION PLANNING. 1977 FINAL REPORT	HS-021 498
Peak, Marwick, Mitchell and Co., 1025 Connecticut Ave. N.W., Washington, D.C. 20036 ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTO-	

february 28, 1978

MATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605	Royal Canadian Mounted Police, Edmonton, Alta., Canada	ROADSIDE SCREENING FOR IMPAIRED DRIVERS IN CANADA	HS-021 589
<b>Peat, Marwick and Partners, Toronto, Ont., Canada</b> ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605	<b>Rudolf Olimpert</b> MINICARS RSV BRAKE SYSTEM		HS-021 535
ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX C: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE MONITORING TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 606	<b>Safety Management Inst.</b> THE RESULTS OF THE NHTSA SURVEY: FOR AN EVALUATION OF THE ADEQUACY AND APPROPRIATENESS OF THE NHTSA UNIFORM HIGHWAY SAFETY STANDARDS		HS-802 302
<b>Peat, Marwick, Mitchell and Co., 1025 Connecticut Ave. N.W., Washington, D.C. 20036</b> ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. APPENDIX B: EVALUATION OF POTENTIAL APPLICATIONS OF AUTOMATIC VEHICLE IDENTIFICATION TO TRAFFIC MANAGEMENT. FINAL REPORT	HS-021 605	<b>San Diego State Univ.</b> ENERGY CONSUMPTION IN URBAN TRANSPORTATION: THE ROLE OF THE POST-1980 AUTOMOBILE		HS-021 550
BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES	HS-021 559	<b>Southern California Res. Inst., Los Angeles, Calif.</b> THE EFFECTS OF ALCOHOL AND VALIUM, SINGLY AND IN COMBINATION, UPON DRIVING-RELATED SKILLS PERFORMANCE		HS-021 588
<b>Princeton Univ.</b> TRANSIENT RESPONSE OF A CARBURETOR ENGINE	HS-021 467	<b>Southwest Res. Inst., Dept. of Engine and Vehicle Res.</b> TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST		HS-021 522
<b>Purdue Univ., Inst. for Interdisciplinary Engineering Studies, West Lafayette, Ind.</b> BALANCING MOBILITY, SAFETY, ENVIRONMENT, ENERGY USE, AND ECONOMICS FOR AUTOMOBILES	HS-021 559	<b>Southwest Res. Inst., San Antonio, Tex.</b> GUIDE FOR MEDICAL EXAMINERS TO DETERMINE FITNESS TO DRIVE BUSES AND TRUCKS IN INTERSTATE COMMERCE		HS-021 583
<b>PPG Industries, Inc., Houston Chemical Co.</b> TRAPPING OF LEAD PARTICULATES IN AUTOMOTIVE EXHAUST	HS-021 522	<b>Stanford Univ. School of Medicine, Div. of Orthopedic Surgery</b> DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?		HS-021 592
<b>Rand Corp.</b> A ROAD TEST CONCEPT FOR DYNAMIC MOTOR VEHICLE DIAGNOSTIC EVALUATION	HS-021 537	<b>Stanford Univ., Dept. of Mechanical Engineering</b> KINEMATICAL IMPLICATIONS OF SIDE SLIP FOR SINGLE-TRACK VEHICLES		HS-021 519
<b>Regie Nationale des Usines Renault (France)</b> EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE	HS-021 552	STEADY TURNING OF SINGLE-TRACK VEHICLES	HS-021 520	
<b>Rochester General Hospital</b> DASHBOARD AND BUMPER KNEE - WILL ARTHRITIS DEVELOP?	HS-021 592	<b>State Farm Mutual Automobile Insurance Co.</b> AUTOMOBILE CRASH DAMAGE: USE OF REPAIR INFORMATION FOR EVALUATING AUTOMOBILE DESIGN CHARACTERISTICS		HS-021 563
STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?	HS-021 536	<b>State Medical Soc. of Wisconsin, Com. on Safe Transportation, Sheboygan Falls, Wis.</b> MEDICAL REPORTING OF DRIVERS WITH EMOTIONAL PROBLEMS		HS-021 576
<b>Rochester General Hospital, Dept. of Orthopaedics</b> INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS	HS-021 594	<b>Talley Industries, Mesa, Ariz.</b> USE OF SODIUM AZIDE FOR AIR CUSHION INFLATOR		HS-021 484

HSL 78-02

<b>Texaco Inc., Res. and Technical Dept.</b> VISCOMETER FOR PREDICTING LOW-TEMPERATURE PUMPABILITY OF ENGINE OILS	HS-020 916	<b>University of Illinois, Dept. of Health and Safety Education, Champaign, Ill.</b> A DECADE OF RESEARCH IN VEHICLE REAR LIGHTING: WHAT HAVE WE LEARNED?	HS-021 577
<b>Texas A and M Univ., Safety Education Prog., College Station, Tex.</b> ALCOHOL EDUCATION CURRICULUM FOR DRIVING WHILE INTOXICATED OFFENDERS	HS-021 590	<b>University of Kansas Medical Center, Dept. of Emergency Medical Training, Kansas City, Kans.</b> IMPACT OF MOTORCYCLE HELMET LAW REPEAL	HS-021 569
<b>Texas A and M Univ., Texas Transportation Inst.</b> THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW	HS-021 570	<b>University of Kansas Medical Center, Dept. of Surgery, Kansas City, Kans.</b> EMERGENCY MEDICAL SERVICES	HS-021 597
<b>Tokyo Univ. of Agriculture and Technology, Japan</b> TRANSIENT RESPONSE OF A CARBURETOR ENGINE	HS-021 467	<b>University of Michigan</b> A SIMULATION PROGRAM FOR LARGE DYNAMIC DEFORMATION OF VEHICLES	HS-021 517
<b>Toledo Area Regional Transit Authority, Ohio</b> A TRANSIT OPERATOR VIEWS TRANSBUS	HS-021 543	<b>DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL VEHICLE MODEL UNDERGOING LARGE DEFLECTIONS</b>	HS-021 514
<b>Toyota Motor Co., Ltd., Material Res. and Process Devel. Dept. (Japan)</b> TOYOTA'S LIGHT-WEIGHT NO-DAMAGE ELASTOMER BUMPER	HS-021 544	<b>INTERACTIVE SIMULATION OF MACHINERY WITH FRICTION AND IMPACT USING DRAM</b>	HS-021 494
<b>Tracor-Jitco, Inc., 1776 E. Jefferson St., Rockville, Md. 20852</b> INNOVATIVE CONCEPTS AND TECHNOLOGY FOR RAILROAD-HIGHWAY GRADE CROSSING MOTORIST WARNING SYSTEMS. VOL. 2. THE GENERATION AND ANALYSIS OF ALTERNATIVE CONCEPTS. FINAL REPORT	HS-021 486	<b>SIMULATION OF A VEHICLE SUSPENSION WITH THE ADAMS COMPUTER PROGRAM</b>	HS-021 516
<b>Traffic Injury Res. Foundation of Canada</b> BARBITURATES AND ALCOHOL IN B.C. [BRITISH COLUMBIA] TRAFFIC FATALITIES	HS-021 587	<b>University of Michigan, Hwy. Safety Res. Inst.</b> STUDDED TIRES AND HIGHWAY SAFETY. FEASIBILITY OF DETERMINING INDIRECT BENEFITS	HS-021 490
<b>U.S. Military Acad., Dept. of Engineering</b> EFFECTS OF EXHAUST MANIFOLD CONFIGURATION ON A TURBOCHARGED ENGINE EMPLOYING CHARGE STRATIFICATION	HS-021 468	<b>University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109</b> ALCOHOL-RELATED CASUALTIES AND ALCOHOL BEVERAGE MARKET RESPONSE TO BEVERAGE ALCOHOL AVAILABILITY POLICIES IN MICHIGAN. VOL. 1. FINAL TECHNICAL REPORT	HS-021 470
<b>University of California, Lawrence Livermore Lab.</b> COMPUTER SIMULATION OF LARGE-DISPLACEMENT IMPACT DYNAMICS	HS-021 518	<b>University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48105</b> FURTHER DEVELOPMENT OF A COMPUTER SIMULATION TO PREDICT THE VISIBILITY DISTANCE PROVIDED BY HEADLAMP BEAMS. FINAL REPORT	HS-021 472
<b>University of Cincinnati, Dept. of Aerospace Engineering</b> VALIDATION OF A TURBULENT FLAME PROPAGATION MODEL FOR A SPARK IGNITION ENGINE	HS-021 466	<b>University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109</b> A REVIEW AND INVESTIGATION OF BETTER CRASH SEVERITY MEASURES: AN ANNOTATED BIBLIOGRAPHY. FINAL REPORT	HS-021 492
<b>University of Florida, College of Law</b> CONSUMER SATISFACTION WITH THE EXTENT OF GOVERNMENTAL INDUCED VEHICLE SAFETY DESIGN AS INDICATED BY JUDGES AND JURORS IN TORT LITIGATION DECISIONS ARISING OUT OF ALLEGED DEFECTIVE DESIGN: PROGNOSIS FOR THE 1980'S	HS-021 541	<b>University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich.</b> VALIDATION OF HUMAN BODY MODELING FOR DYNAMIC SIMULATION	HS-021 521

february 28, 1978

<b>University of Michigan, Hwy. Safety Res. Inst., Huron Pkwy. and Baxter Rd., Ann Arbor, Mich. 48109</b> PUBLIC ATTITUDES ON RESTRAINT SYSTEMS: AN ANNOTATED BIBLIOGRAPHY	HS-021 493	PROBLEMS IN RELATING HIGHWAY AND MOTOR VEHICLE SAFETY PROGRAMS TO CHARACTERISTICS OF THE PUBLIC	HS-021 561
<b>University of Montreal, Departments of Demography and of Social and Preventive Medicine, Canada</b> ROAD INJURIES IN QUEBEC [CANADA] (1974): NATURE, SEVERITY AND DIRECT COSTS	HS-021 591	<b>University of Western Ontario, London, Ont., Canada</b> ESTABLISHMENT OF AN AIR-BRAKE EQUIPPED MOTOR VEHICLE ACCIDENT DATA BASE FOR SOUTHWESTERN ONTARIO [CANADA]	HS-021 584
<b>University of North Carolina, Hwy. Safety Res. Center</b> THE IMPACT OF A MOTORCYCLE LIGHTS-ON LAW	HS-021 570	INVESTIGATION OF INJURY MECHANISMS ASSOCIATED WITH FULLY RESTRAINED PASSENGER VEHICLE OCCUPANTS IN LONDON, ONTARIO [CANADA]	HS-021 579
<b>University of Pennsylvania, Mechanical Engineering and Applied Mechanics Dept.</b> DYNAMIC ANALYSIS OF MACHINERY VIA PROGRAM DYMAC	HS-021 503	<b>University of Western Ontario, Multi-Disciplinary Accident Investigation Team, London, Ont., Canada</b> THE CORONER'S SYSTEM IN ONTARIO, CANADA: INVESTIGATION AND INQUEST IN AUTOMOTIVE MEDICINE	HS-021 599
<b>University of Pittsburgh, Dept. of Pediatrics and Community Medicine</b> EVALUATION OF THREE EDUCATIONAL PROGRAMS DESIGNED TO INCREASE THE CRASH PROTECTION OF INFANTS IN CARS	HS-021 567	<b>University of Wisconsin, Madison, Wis.</b> FATALLY INJURED TRUCK DRIVERS	HS-021 600
<b>University of Rochester School of Medicine and Dentistry</b> INJURY CHARACTERISTICS OF RIDERS OF MOTORCYCLES, MINIBIKES, AND MOPEDS	HS-021 594	<b>Volkswagenwerk Res. Div.</b> COMPATIBILITY OF DIESEL ENGINES WITH VEHICLES INCORPORATING ADVANCED CRASHWORTHINESS	HS-021 548
<b>University of Rochester School of Medicine and Dentistry, Rochester, N.Y.</b> THE VEHICLE-PRESENTATION FOR PANEL, "INVESTIGATION PLUS ACTION"	HS-021 596	<b>Wayne T. VanWagoner and Associates, Inc., Salt Lake City, Utah</b> INVESTIGATING THE ROADWAY ENVIRONMENT	HS-021 595
<b>University of Rochester, School of Medicine and Dentistry</b> STATIC PASSIVE OCCUPANT RESTRAINT SYSTEMS, WITHOUT AIRBAGS AND WITHOUT BELTS - IS IT POSSIBLE?	HS-021 536	<b>Wells Res. Co.</b> TAXICAB OPERATING CHARACTERISTICS. FINAL REPORT	HS-021 482
<b>University of Saskatchewan, Dept. of Surgery, Canada</b> A METHOD FOR THE COMPREHENSIVE RECORDING AND ANALYSIS OF THE EFFECTIVENESS OF AN EMERGENCY MEDICAL SYSTEM IN AN URBAN AND RURAL AREA	HS-021 573		
<b>University of Southern California, Inst. of Safety and Systems Management, Los Angeles, Calif. 90007</b> MULTIDISCIPLINARY ACCIDENT INVESTIGATION: FREEWAY OFF-RAMP DEPARTURE; SCHOOL BUS ROLLOVER; 29 FATALITIES	HS-802 303		
<b>University of Toronto, Dept. of Civil Engineering, Toronto, Ont., Canada</b> A STUDY OF SOME SCHOOLBUS CRASHES	HS-021 585		
<b>University of Vermont</b> ALICE IN THE WONDERLAND OF MOTOR VEHICLE SAFETY - CONCEPTUAL AND PRACTICAL			



## Contract Number Index

<b>DOT-FH-11-8274</b>		
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	HS-021 583	
<b>DOT-FH-11-8779</b>		
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<b>DOT-FH-11-8836</b>		
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	HS-021 607	
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	HS-021 608	
<b>DOT-FH-11-8845</b>		
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	HS-021 498	
<b>DOT-FH-11-9158</b>		
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	HS-021 491	
<b>DOT-FH-11-9198</b>		
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	HS-021 606	
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<b>DOT-HS-01617</b>		
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	HS-802 687	
<b>DOT-HS-034-3-535</b>		
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	HS-021 602	
<b>DOT-HS-053-3-609</b>		
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	HS-802 720	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
	HS-802 722	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
	HS-802 723	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
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	HS-802 726	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
	HS-802 727	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
	HS-802 728	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
	HS-802 729	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
	HS-802 730	
<b>City of Kansas City, Mo.; Midwest Res. Inst., 425 Volker Blvd., Kansas City, Mo. 64110</b>		
	HS-802 731	
<b>Kansas City Alcohol Safety Action Proj., 414 East 12th St., Kansas City, Mo. 64106</b>		
	HS-802 715	
<b>Kansas City Alcohol Safety Action Proj., 414 East 12th St., Kansas City, Mo. 64106</b>		
	HS-802 721	
<b>Kansas City Alcohol Safety Action Proj., 414 East 12th St., Kansas City, Mo. 64106</b>		
	HS-802 725	
<b>DOT-HS-4-00855</b>		
University of Michigan		
	HS-021 517	
<b>DOT-HS-5-01225</b>		
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	HS-802 320	
<b>DOT-HS-5-01254</b>		
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Calspan Corp., Buffalo, N.Y. 14221		
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		HSL 78-02
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Calspan Corp., Buffalo, N.Y. 14221	HS-802 683	HS-802 702
Calspan Corp., Buffalo, N.Y. 14221	HS-802 684	Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027
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Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221	HS-802 675	Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221	HS-802 676	HS-802 706
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221	HS-802 677	Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027
<b>DOT-HS-6-01214</b>		HS-802 707
University of Southern California, Inst. of Safety and Systems Management, Los Angeles, Calif. 90007	HS-802 303	<b>DOT-HS-6-01417</b>
		Safety Management Inst.
		HS-802 302
<b>DOT-HS-6-01307</b>		<b>DOT-HS-6-01470</b>
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		Calspan Corp., Buffalo, N.Y. 14221
		HS-802 709
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Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 694	HS-021 487
		Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 695	HS-021 488
		<b>DOT-TSC-841-1</b>
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 696	Cincinnati Electronics Corp., 2630 Glendale Rd., Cincinnati, Ohio 45241
		HS-021 485
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 697	<b>DOT-TSC-842-2</b>
		Tracor-Jitco, Inc., 1776 E. Jefferson St., Rockville, Md. 20852
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 698	HS-021 486
		<b>EPA-R803520-01-0</b>
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 699	New York State Dept. of Environmental Conservation, Div. of Air Resources
		HS-021 527
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 700	<b>EPA-68-02-2232</b>
		Olson Labs., Inc.; Environmental Protection Agency
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 701	HS-021 525
		<b>ERDA-W-7405-Eng-48</b>
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 702	University of California, Lawrence Livermore Lab.
		HS-021 518
<b>MDPH-384117</b>		<b>MDPH-384117</b>
Dynamic Science Inc., 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027	HS-802 703	University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109
		HS-021 470

february 28, 1978

**MVMA-361122**

University of Michigan, Hwy. Safety Res. Inst., Ann Arbor,  
Mich. 48109

HS-021 492

**NH-Proj-605-1355-44**

University of Montreal, Departments of Demography and of  
Social and Preventive Medicine, Canada

HS-021 591

**NSF-Eng72-04070-A02**

University of Pennsylvania, Mechanical Engineering and  
Applied Mechanics Dept.

HS-021 503

**NSF-ENG-75-18680**

Stanford Univ., Dept. of Mechanical Engineering

HS-021 520

**NSF-GK-31800**

Deere and Co.; University of Michigan

HS-021 516

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Mass. 02158

HS-021 489

**UM7204-C128**

University of Michigan, Hwy. Safety Res. Inst., Ann Arbor,  
Mich. 48105

HS-021 472

## Report Number Index

<b>AL-78542-06-1</b>		
	HS-021 487	<b>GEC-5191.1</b>
<b>AR-3</b>	HS-021 488	<b>GEC-5191-Vol-1</b>
	HS-802 721	<b>GEC-5191-Vol-2</b>
<b>AR-3-App-H</b>	HS-802 725	<b>GEC-5191-Vol-3</b>
<b>AR-7</b>	HS-021 496	<b>GEC-5191-Vol-4</b>
<b>AY-51-201-801</b>	HS-021 497	<b>GEC-5348-Vol-1</b>
<b>CED-77-107</b>	HS-021 471	<b>GEC-5348-Vol-2</b>
<b>CFP-0058</b>	HS-021 484	<b>GEC-5348-Vol-3</b>
<b>DOT-TPI-10-77-22</b>	HS-021 482	<b>GEC-5348-Vol-4</b>
<b>DOT-TSC-FRA-76-19.I</b>	HS-021 485	<b>KCASAP-AR-1</b>
<b>DOT-TSC-FRA-76-19.II</b>	HS-021 486	<b>MRI-AR-1-Pt-3</b>
<b>DOT-TSC-OST-77-1.I</b>	HS-021 487	<b>MRI-AR-2-Pt-3</b>
<b>DOT-TSC-OST-77-1.II</b>	HS-021 488	<b>MRI-AR-2-Pt-5</b>
<b>DOT-TSC-OST-77-26</b>	HS-021 489	<b>MRI-AR-3-Pt-1</b>
<b>FHWA-HP-HS-S75</b>	HS-021 609	<b>MRI-AR-3-Pt-3</b>
<b>FHWA-RD-76-135</b>	HS-021 607	<b>MRI-AR-3-Pt-6</b>
<b>FHWA-RD-76-137</b>	HS-021 608	<b>MRI-AR-3-Pt-7</b>
<b>FHWA-RD-77-70</b>	HS-021 497	<b>MRI-AR-3-Pt-8</b>
<b>FHWA-RD-77-89</b>	HS-021 605	<b>MRI-SR-10</b>
<b>FHWA-RD-77-90</b>	HS-021 606	<b>MRI-SR-11</b>
<b>FHWA-RD-77-93</b>	HS-021 491	<b>MRI-SR-12</b>
<b>FHWA/SES-77/11</b>	HS-021 498	<b>MRI-SR-13</b>
<b>FRA/ORD-77/37.I</b>	HS-021 485	<b>MRI-SR-7</b>
<b>FRA/ORD-77/37.II</b>	HS-021 486	<b>MRI-SR-9</b>
		<b>HS-802 718</b>
		<b>HS-802 716</b>
		<b>HS-802 728</b>
		<b>HS-802 723</b>
		<b>HS-802 729</b>
		<b>HS-802 726</b>
		<b>HS-802 724</b>
		<b>HS-802 719</b>
		<b>HS-802 717</b>
		<b>HS-802 715</b>
		<b>HS-802 712</b>
		<b>HS-021 509</b>
		<b>HS-021 506</b>
		<b>HS-021 505</b>
		<b>HS-021 504</b>
		<b>HS-021 508</b>

**HSL 78-02**

<b>NAD-41</b>		<b>SAE-770048</b>	
	HS-810 308		HS-021 469
<b>NCHRP-176</b>		<b>SAE-770049</b>	
	HS-021 490		HS-021 503
<b>OCA-577-1</b>		<b>SAE-770050</b>	
	HS-802 713		HS-021 494
<b>PB-257 909</b>		<b>SAE-770051</b>	
	HS-021 472		HS-021 514
<b>PR-07</b>		<b>SAE-770052</b>	
	HS-802 709		HS-021 515
<b>PR-11</b>		<b>SAE-770053</b>	
	HS-802 671		HS-021 516
<b>PR-12</b>		<b>SAE-770054</b>	
	HS-802 672		HS-021 517
<b>PR-13</b>		<b>SAE-770055</b>	
	HS-802 673		HS-021 518
<b>PR-14</b>		<b>SAE-770056</b>	
	HS-802 674		HS-021 519
<b>PR-15</b>		<b>SAE-770057</b>	
	HS-802 675		HS-021 520
<b>PR-16</b>		<b>SAE-770058</b>	
	HS-802 676		HS-021 521
<b>PR-17</b>		<b>SAE-770059</b>	
	HS-802 677		HS-021 522
<b>PR-18</b>		<b>SAE-770060</b>	
	HS-802 678		HS-021 523
<b>PR-19</b>		<b>SAE-770061</b>	
	HS-802 679		HS-021 524
<b>PR-2</b>		<b>SAE-770062</b>	
	HS-802 687		HS-021 525
<b>PR-20</b>		<b>SAE-770063</b>	
	HS-802 680		HS-021 526
<b>PR-21</b>		<b>SAE-770064</b>	
	HS-802 681		HS-021 527
<b>PR-22</b>		<b>SAE-770065</b>	
	HS-802 682		HS-021 528
<b>PR-23</b>		<b>SAE-770075</b>	
	HS-802 683		HS-021 529
<b>PR-24</b>		<b>SAE-770076</b>	
	HS-802 684		HS-021 530
<b>PR-25</b>		<b>SAE-770077</b>	
	HS-802 685		HS-021 531
<b>SAE-760560</b>		<b>SAE-770078</b>	
	HS-020 722		HS-021 532
<b>SAE-770046</b>		<b>SAE-770079</b>	
	HS-021 466		HS-021 533
	HS-021 467	<b>SAE-770632</b>	
<b>SAE-770047</b>	HS-021 468	<b>Test-02</b>	HS-020 916
			HS-802 692

february 28, 1978

<b>Test-03</b>	HS-802 693
<b>Test-04</b>	HS-802 694
<b>Test-05</b>	HS-802 695
<b>Test-06</b>	HS-802 696
<b>Test-07</b>	HS-802 697
<b>Test-08</b>	HS-802 698
<b>Test-09</b>	HS-802 699
<b>Test-10</b>	HS-802 700
<b>Test-11</b>	HS-802 701
<b>Test-12</b>	HS-802 702
<b>Test-13</b>	HS-802 703
<b>Test-14</b>	HS-802 704
<b>Test-15</b>	HS-802 705
<b>Test-16</b>	HS-802 706
<b>Test-17</b>	HS-802 707
<b>Test-18</b>	HS-802 708
<b>UM-HSRI-HF-74-26</b>	HS-021 472
<b>UM-HSRI-77-22</b>	HS-021 492
<b>UM-HSRI-77-32</b>	HS-021 493
<b>UM-HSRI-77-37-1</b>	HS-021 470
<b>USG-1502-Pt-4</b>	HS-021 483
<b>ZM-6049-V-6</b>	HS-802 686

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